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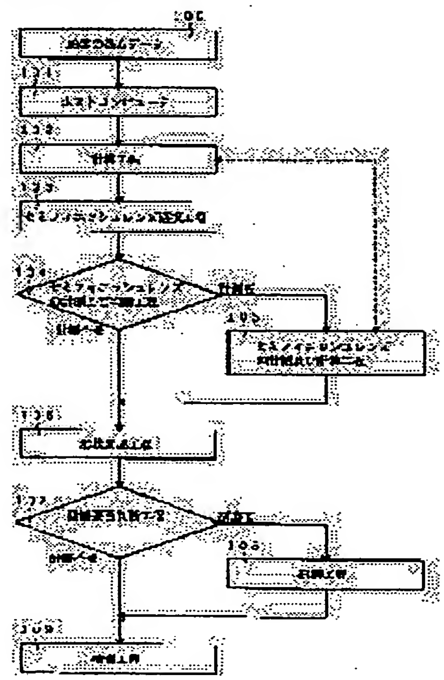
(54) MANUFACTURE OF SPECTACLE LENS AND DEVICE THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method in which a processing plate and a large amount of forms for molding are made unnecessary, and even an inner side progressive multifocus spectacle lens can be manufactured in a short time of delivery and at a low cost.
SOLUTION: A calculating process 102 to calculate the combination of curved surface to satisfy a prescription, and produce a data for NC processing; a process 103 to select a semifinish lens corresponding to the prescription; and a process 106 to NC process the inner side or the outer side of the semifinish lens depending on the data for NC process, and create in a desired curved surface form; are provided. Various sorts and types of spectacle lenses including an inner surface progressive multifocus lens are made possible to be manufactured at a low cost and in a short time of delivery, by making it possible to manufacture a spectacle lens by the NC process.



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CLAIMS

[Claim(s)]

[Claim 1] NC configuration of the field by the side of the body of a spectacle lens, or the field by the side of an eyeball which one of fields deletes, carries out appearance, and performs processing based on the data for numerical-control processing at least -- creation -- the manufacture method of the spectacle lens characterized by having a process

[Claim 2] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by the thing which imitate and performs polish of the field where it deleted, appearance was carried out at the process, and processing was performed by polish, and for which it imitates and has a polish process

[Claim 3] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by having NC polish process performed based on the data for numerical-control processing which specified the field configuration which grinds polish of the field where it deleted, appearance was carried out at the process, and processing was performed

[Claim 4] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by processing it by a semi finish lens's deleting a process and carrying out appearance

[Claim 5] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by having the data origination process for processing which considers the conditions of the wearing person of a spectacle lens before a process, and creates the aforementioned data for numerical-control processing for every spectacle lens for processing

[Claim 6] a claim 5 -- setting -- the aforementioned data-origination process for processing -- then, the semi finish lens selection process which chooses the semi finish lens suitable for processing it by deleting and carrying out appearance based on the aforementioned data for numerical-control processing -- having -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by to process it by the semi finish lens chosen at the aforementioned semi-finish lens selection process deleting at a process, and carrying out appearance

[Claim 7] claims 4 or 6 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by measuring the configuration of the field for [of the semi finish lens which deletes and carries out appearance before a process and serves as a candidate for processing] processing, and having an amendment amendment process for the aforementioned data for

numerical-control processing

[Claim 8] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by processing it by deleting and carrying out appearance so that maximum surface roughness Rmax of the field where the process was deleted, appearance was carried out, and processing was performed may be set to 0.010mm or less

[Claim 9] a claim 2 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by processing it by deleting and carrying out appearance so that maximum surface roughness Rmax of the field where the process was deleted, appearance was carried out, and processing was performed may be set to 0.001mm or more and 0.010mm or less

[Claim 10] a claim 1 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by processing it by deleting and carrying out appearance so that the amount of level differences near [which is generated in case a process is deleted, appearance is carried out and processing is performed] the point of inflection may be set to 0.005mm or less except for a field relative roughness component

[Claim 11] a claim 2 -- setting -- the aforementioned NC configuration -- creation -- the manufacture method of the spectacle lens characterized by processing it by deleting and carrying out appearance so that the amount of level differences near [which is generated in case a process is deleted, appearance is carried out and processing is performed] the point of inflection may be set to 0.0005mm or more and 0.005mm or less except for a field relative roughness component

[Claim 12] the NC configuration which the storage section which can memorize the data for numerical-control processing for [of the field by the side of the body of a spectacle lens or the field by the side of an eyeball] processing it by one of fields' deleting at least and carrying out appearance, the means which can set a spectacle lens, and the field which are set as the processing object of this spectacle lens can delete, can carry out appearance, and can perform processing based on the data for numerical-control processing -- creation -- the manufacturing installation of the spectacle lens characterized by to have a means

[Claim 13] a claim 12 -- setting -- the aforementioned NC configuration -- creation -- the manufacturing installation of the spectacle lens characterized by the thing which can imitate and can perform polish of the field where it deleted, appearance was carried out with the means, and processing was performed by polish, and for which it imitates and has a polish means

[Claim 14] a claim 12 -- setting -- the aforementioned NC configuration -- creation -- polish of the field where it deleted, appearance was carried out at the process, and processing was performed It has NC polish means which can be performed based on the data for numerical-control processing which specified the field configuration to grind. the aforementioned storage section The manufacturing installation of the spectacle lens characterized by being what can memorize the data for numerical-control processing which specified the field configuration ground with the aforementioned NC polish means in addition to the data for numerical-control processing which specified the field configuration which it begins to delete.

[Claim 15] The manufacturing installation of the spectacle lens characterized by having a processing data setting means to set the data for numerical-control processing which considered the conditions of the wearing person of a spectacle lens as the aforementioned storage section for every spectacle lens for processing in a claim 12.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the manufacture method of a spectacle lens, and equipment.

[0002]

[Description of the Prior Art] A spectacle lens is divided roughly into a single focal lens and a multifocal lens. The general manufacture range of each lens, an inventory gestalt, and the conventional manufacture method are explained. In addition, below, especially the spectacle lens made from plastics is explained.

[0003] First, a single focal lens is explained. Although a single focal lens is used for eyesight reform of myopia or the hyperope, an example of the manufacture range is shown in drawing 6 . The range about -15.00 [D] to +10.00 [D] is prepared in astigmatism frequency (it considers as C frequency below) by this at 0.25 [D] steps by 0.25 [D] steps as well as S frequency in the range about 0.25 [D] to 6.00 [D] with the number of spherical degrees (it considers as S frequency below). However, in the example shown in a view 6, the range of C frequency decreases gradually, if S frequency exceeds -9.00 [D]. However, the kind of lens turns into no less than 2225 kinds only in the manufacture range shown in a view 6, and has some which have a latus manufacture range further depending on the refractive index of a lens, or a design.

[0004] Next, although it is the gestalt of stock, as for the range surrounded in the S frequency -10.00 [D] to +6.00 [D], and C frequency 0.25[D] -2.00[D], especially in stock as a shaping lens which is a portion with many orders received and is called finish lens is common. In stock [as for ranges other than a finish lens / order-received frequency] as a shaping lens (it considers as a semi-finish lens below) called semi finish lens which is thicker than a finishing size as for thickness, without in stock [for a low reason] as a finish lens, and can manufacture the lens of the frequency for a number step.

[0005] Next, the manufacture method of a single focal lens is explained. In order to specify the field by the side of an eyeball as the punch which became a concave surface in order to specify the field by the side of the body of a lens, a single focal lens combines convex ****** female mold, and is manufactured by cast molding which pours in and fabricates a lens material in a mold. In order that a finish lens may obtain desired frequency, in the case of the spherical lens (it considers as a spherical lens below) which has only S frequency, the spherical surface or the symmetry-of-revolution aspheric surface is prepared in the concave surface of a punch, and it prepares the spherical surface in the convex side of female mold. On the other hand, in the case of the astigmatism lens (following astigmatism lens) which has C frequency in

addition to S frequency, the spherical surface or the symmetry-of-revolution aspheric surface is prepared in the concave surface side of a punch, it establishes a toric side in the convex side of female mold, and is manufactured by cast molding combining these. Since the lens released from mold after fabrication has the optical surface of a satisfying enough precision, it turns into a completion lens through a dyeing process, a hard-coat process, a vacuum evaporationo process, etc.

[0006] There is also the manufacture method which processes a semi finish lens and is used as a finish lens on the other hand. As well as the case of the spherical lens of a finish lens, a semi finish lens combines a punch and female mold, and it is manufactured by cast molding so that thickness may become thick rather than a finishing size. The lens of special prescription which specifies the above-mentioned lens and the above-mentioned amount of prism of low frequency of order-received frequency, and the thickness of a lens is specially treated as an order lens, and needs to manufacture the lens with which sizes differ according to prescription. If the lens of this special order is a spherical lens according to prescription, it will give sand credit processing and polish processing which resembled wrapping processing after carrying out rough machining of the concave surface side of a semi finish lens so that it may become the toric side configuration of almost a request about the concave surface side of a semi finish lens at the spherical surface of almost a request, if it is an astigmatism lens, and it finishes the optical surface of a lens precisely. At this sand credit process and a polish process, the lens held at the fixture of exclusive use is put on the processing pan with which a configuration or curvature became settled beforehand, and a lens front face is processed by printing a lens and a processing pan relatively and moving lap material, pouring water into a lens processing side. At a sand credit process, it finishes to the precision from which the unevenness on the front face of a lens is made small, and desired appearance is acquired at a polish process. A series of processing methods of this rough machining, sand credit, and polish are named generically, and are called polish processing.

[0007] By the manufacture method of a finish lens, since the lens of special prescription which specifies the above-mentioned amount of prism and the thickness of a lens has some which cannot be manufactured, even if it is the manufacture range of a finish lens, it is necessary to manufacture it from a semi finish lens. Therefore, if the manufacture range shown in a view 6 is taken for an example, sand credit and the processing pan used for polish processing need to prepare in advance the thing of the configuration from which it differs for 2225 kinds [being the same] as a lens, or curvature.

[0008] Usually, the lens obtained in this way is called polish lens. Since this polish lens has the optical surface of a satisfying enough precision, it turns into a completion lens through a dyeing process, a hard-coat process, a vacuum evaporationo process, etc. like a finish lens.

[0009] Next, the manufacturing installation for obtaining the aforementioned polish lens is explained. first, the generator into which the so-called curve generator and this so-called which delete the field of fixed curvature and can carry out the broth of it are developed into, and a false toric side can also be processed uses the equipment which performs rough-planed processing -- having -- prescription -- responding -- moreover, the spherical surface near a configuration or the toric side of a request by the thickness in a back process which processed it and took ** into consideration -- grinding -- or cutting is carried out The equipment which performs sand credit processing and polish processing is the same mechanism fundamentally, and is equipped with the mechanism in which all print a processing pan and a lens relatively and move them, and a means to supply the means and lap material which generate a pressure between a processing pan and a lens. About this mechanism, what performs triangular

movement of the lens called a Udagawa style, for example and rotation of a processing pan, and the thing which performs the circular motion of the lens called AO formula and rotation of a processing pan are known. In addition, it is necessary to choose a processing pan according to prescription in the case of processing. Moreover, pads are exchanged according to the quality of the material and the process of a lens. Incidentally, as for a glass spectacle lens as well as the case of the spectacle lens made from the aforementioned plastics, it is common rough-planed processing and to sand-credit-process it, to carry out polish processing and to manufacture.

[0010] Then, a multifocal lens is explained. A multifocal lens is divided into a progressive multifocal lens and a superimposed-focal-spot lens. These multifocal lenses realize the function of the single focal lens for ******, and the function of the single focal lens for ****** with one lens.

[0011] Therefore, eyesight reform of ****** and ****** is possible, without hanging spectacles again, and there is no troublesomeness accompanying a substitute.

[0012] a progressive multifocal lens -- the superficies side of a lens -- getting it blocked -- it is characterized by having the progressive side which a focal distance continues and changes to a convex side; and types, such as BAIFOKARU (double focus) and TORIFOKARU (Mie focus), commercialize a superimposed-focal-spot lens -- having -- **** -- the superficies side of a lens -- getting it blocked -- it is characterized by having a curved surface for obtaining two or three focal distances to a convex side Therefore, unlike a single focal lens, a multifocal lens has the frequency for ******, and the frequency for ******, and calls the absolute value of the difference of these two frequencies degree of subscription.

[0013] In addition, a mainstream progressive multifocal lens is explained to an example also in a multifocal lens now henceforth. Although it is the manufacture range of a progressive multifocal lens, the range of S frequency and C frequency is usually the same as the manufacture range shown in a view 6. In addition, in the case of a progressive multifocal lens, the above-mentioned degree of subscription has 13 step **********'s common at 0.25 [D] steps from 0.50 [D] to 3.50 [D]. Moreover, recently, designing separately the lens for right eyes and the lens for left eyes, respectively is becoming common. Even if it is the same manufacture range as a single focal lens in the case of a progressive multifocal lens, an astigmatism prescription lens besides this degree of subscription, and a right-and-left separate installation meter Although the kind of lens of the aforementioned manufacture range will serve as 9942946 kinds and a huge number if it also includes a part for an astigmatism shaft since it is necessary to set up the astigmatism shaft of prescription 180 kinds at 1 [**] step for every lens by making the main meridian of a progressive side into a criteria position The above special prescription lenses are not contained in this.

[0014] Next, although it is the manufacture method of a progressive multifocal lens, since a progressive multifocal lens is a total special order lens fundamentally, it is manufactured at a convex side according to prescription with the almost same method and equipment as a case of the polish lens of the aforementioned single focal lens from the semi finish lens which has a progressive side. That is, a semi finish lens is manufactured by cast molding so that the field by the side of the body of a spectacle lens (convex side) turns into a progressive side of a predetermined performance, the field by the side of an eyeball (concave surface side) may finish and thickness may become thick rather than a size, and according to prescription, if the concave surface side of a semi finish lens is a spherical lens, it will carry out polish processing so that it may become a desired toric side configuration at the desired spherical surface, if it is an astigmatism lens. Thus, in the astigmatism prescription by the progressive multifocal

lens, it is necessary to set the astigmatism shaft which made the criteria position the main meridian of the progressive side by the side of a convex to a concave surface side, and it differs from the case where this point is the polish lens of the aforementioned single focal lens on manufacture. In addition, if it is the manufacture range shown in drawing 6 , since the number of the kinds of the spherical surface by which creation is carried out to a concave surface side, and toric side will turn into the number of the kinds of processing pan, a processing pan becomes the 2225 same kinds as the case of a single focal lens.

[0015] Thus, the semi finish lens for progressive multifocal lenses combines the punch which has a progressive side in a concave surface side, and the female mold which has the spherical surface in a convex side, and it is manufactured by cast molding so that thickness may become thick rather than a finishing size. Moreover, the lens which has high S frequency and the degree of subscription of order-received frequency in the manufacture range may combine the punch which has a progressive side in a concave surface side, and the female mold which has the spherical surface in a convex side, and may manufacture a finish lens by cast molding. However, in stock [the finish lens of a progressive multifocal lens is very little, and / 95% or more / as a semi finish lens] generally.

[0016] By the way, the manufacture method that the progressive multifocal lens of an order lens will also raise the manufacture ratio of a finish lens to a limit specially is proposed by JP,5-19212,A. This manufacture method manufactures most order lenses by cast molding specially, and the manufacture ratio of a finish lens is over 90% in spite of the progressive multifocal lens. The manufacture method obtains the lens which arranges the mold for a kind corresponding to the manufacture range beforehand, chooses the punch and female mold for obtaining desired frequency according to prescription of a customer, combines this, and is satisfied [with carrying out cast molding] of prescription.

[0017] The total becomes 130 kinds, when the degree of subscription specifically considered as 13 steps as well as the above in the manufacture range shown in drawing 6 , and the kind of punch which has a progressive side in a concave surface side divides the manufacture range in five base curve partitions and it considers as a right-and-left separate installation meter. Moreover, the female mold which is used in order that the female mold which is used in order to manufacture a spherical-surface type progressive multifocal lens combining the 130 aforementioned kinds of punches, and which has the spherical surface in a convex side may manufacture 100 kinds of astigmatism type progressive multifocal lenses similarly and which has a toric side in a convex side arranges 2100 kinds and a total of 2430 kinds of molds, and manufactures a finish lens. In addition, after setting the astigmatism shaft of female mold as a criteria position for the main meridian of the progressive side of a punch according to prescription, cast molding of the case of an astigmatism type progressive multifocal lens is carried out. In addition, about the lens of special prescription, and the lens of the frequency exceeding the aforementioned manufacture range, it is manufactured by polish processing from a semi finish lens as well as the above.

[0018]

[Problem(s) to be Solved by the Invention] however, by the manufacture method of the spectacle lens by polish processing shown in the aforementioned background technology, the processing pan was used in the first place -- lap -- since it is processing, it is necessary to produce a processing pan the refractive-index exception of a lens, and according to frequency With the equipment of exclusive use, grinding is cut or carried out and a processing pan is made by the configuration of a request of aluminum, reinforced plastics, firing urethane, etc. a processing pan -- 0.25[-- it is necessary to keep step with every D] at a still finer step depending on the frequency range In the case of the manufacture range shown in a

view 6, the kind becomes a part more than for the kind of a lens, i.e., 2225 pieces. The refractive index of the lens material used as a plastic lens for the present spectacles has four common kinds, 1.50, 1.56, 1.60, and 1.67, and since the frequency with the same configuration of a processing pan also changes with refractive indexes of a lens, the required number becomes 8900 or more pieces.

[0019] The manufacture cost of a processing pan is needed as a running cost in cost as the management man day of these processing pan and also a storage space, and an initial cost. In addition, plastics and glass are not asked on the manufacture time for delivery of a processing pan, and the principle of processing a point except cost for productivity reservation, but it is only beginning to delete rough-planed processing in the configuration near a desired configuration, and the configuration precision of a processing side is decided by sand credit processing and the polish processing process which imprint the configuration of a processing pan. Therefore, in order to guarantee configuration precision, it has many troubles -- there is the need of managing strictly the processing error at the time of manufacture of the processing pan which is the basis.

[0020] Furthermore, conventionally, the curved surface which combined the progressive side by which creation was carried out to the convex side of a lens, and the spherical surface or the toric side by which creation was carried out to the concave surface side according to prescription is generated on the whole surface by the side of the concave surface of a lens, and the spectacle lens of raising an optical property by leaps and bounds is proposed by Japanese Patent Application No. 7-306189. The lens which has such a curved surface in a lens concave surface side will be henceforth called inside successive promotion multifocal lens. This inside successive promotion multifocal lens can be manufactured also by the lens manufacture method by cast molding shown in aforementioned JP,5-19212,A.

[0021] The case where the inside successive promotion multifocal lens of a type which has the spherical surface in a lens convex side here is manufactured in the manufacture range shown in drawing 6 is considered. First, the kind of punch which has the spherical surface in a concave surface side is made into ten kinds of 10 base-curve partitions. Next, although it is the female mold combined with a punch, in S frequency and C frequency, no less than a total of 9940320 kinds need to hold the female mold which has the curved surface which combined further 2626 kinds of toric-in female mold which has progressive side on spherical-surface prescription lenses at convex side sides according to a progressive side and prescription for astigmatism prescription lenses for every astigmatism shaft in a convex side at 0.25 [D] steps at 0.25 [D] steps. The number of possession of the female mold per kind is temporarily reached only at mold cost also as ten sheets also at hundreds of billions of yen. Moreover, it has troubles, like the special prescription lens which specifies the amount of prism and the thickness of a lens by the management of the stock control of the mold of the kind of only this itself being unreal, and not being realized and the according to this cast molding as stated further above lens manufacture method has some which cannot be manufactured.

[0022] Moreover, the curve generator conventionally used for the creation of the field by the side of an eyeball etc. is completely impossible for the spherical surface or a toric side generating the curved surface which combined the progressive side, the spherical surface, or the toric side which processing could not do but was shown above on the structure and the principle which prints with a processing pan and is processed.

[0023] Then, in this invention, it aims above at offering actually the manufacture method of a spectacle lens and manufacturing installation which can be supplied completely for the inside successive promotion

multifocal lens which cannot be supplied by the conventional manufacture method. furthermore, the manufacture method by polish processing not only using a progressive multifocal lens but the conventional processing pan -- instead of -- a short period of time -- a low cost -- a variety -- it is also making into the purpose to offer the manufacture method and the manufacturing installation which can manufacture a busy spectacle lens, and it aims at offering the manufacture method and the manufacturing installation which can omit the processing pan itself and can omit the manufacture cost of a processing pan and a management man day, a storage space, etc. Moreover, the manufacture period of the processing pan which required several months conventionally also makes it the purpose of this invention to suppose that it is unnecessary and to enable large cost cut and time-for-delivery shortening.

[0024]

[Means for Solving the Problem] for this reason, this invention -- setting -- the field of a spectacle lens -- based on the data for numerical-control processing (it may be hereafter called "the data for NC processing"), it is made to perform creation namely, the manufacture method of the spectacle lens of this invention -- NC configuration of the field by the side of the body of a spectacle lens, or the field by the side of an eyeball which one of fields deletes, carries out appearance, and performs processing based on the data for numerical-control processing at least -- creation -- it is characterized by having a process Moreover, it sets to the manufacturing installation of the spectacle lens of this invention. The storage section which can memorize the data for numerical-control processing for [of the field by the side of the body of a spectacle lens, or the field by the side of an eyeball] processing it by one of fields beginning to delete at least, NC configuration which the means which can set a spectacle lens, and the field set as the processing object of this spectacle lens can delete, can carry out appearance, and can perform processing based on the data for numerical-control processing -- creation -- it is characterized by having a means

[0025] NC processing to which the manufacture method of the spectacle lens of this invention and the manufacturing installation are not adopted as manufacture of the conventional spectacle lens -- the configuration of the field of a spectacle lens itself -- creation -- it can manufacture only by changing the data for NC processing using the manufacturing installation in which the spectacle lens equipped with what curved surface was also common, or the manufacturing installation of a few kinds by being characterized by adopting it as processing and using the manufacture method of this invention, or a manufacturing installation Therefore, in this invention, the field by the side of the eyeball of the inside successive promotion multifocal lens by which a progressive side which is different to every [of a spectacle lens] wearing person (a user, customer), and the toric side were compounded can also be processed by changing the data for NC processing, and an inside successive promotion multifocal lens can be completely supplied by using the manufacture method of this invention, and a manufacturing installation. moreover, only changing the data for NC processing in this invention -- a variety -- since a busy spectacle lens can be manufactured -- beforehand -- a variety -- a busy processing pan is manufactured and it becomes unnecessary to manage them Therefore, a spectacle lens various type can be supplied by the low price, and it becomes possible to also shorten the time for delivery sharply.

[0026] It is also possible to carry out with the single processing method or processing equipment from the creation of the field configuration of a spectacle lens to finishing using NC processing. However, in the spectacle lens of which high profile irregularity is required, floor to floor time can be sharply shortened by changing the processing method or processing equipment in an intermediate stage from the creation of a field configuration to finishing of a lens side. For example, after generating a field configuration by NC

processing, production time can be sharply shortened by grinding by imitating and finishing a lens side. Moreover, production time can be shortened also by performing NC polish process that NC processing process performs polish processing based on the data for numerical-control processing which specified the field configuration to grind later for having generated the field configuration. furthermore -- the point of shortening production time -- NC configuration -- creation -- it is effective to process it by a semi finish lens's deleting and carrying out appearance in a process

[0027] thus -- since the spectacle lens equipped with what field can also be manufactured by changing the data for NC processing in the manufacture method of the spectacle lens of this invention, and a manufacturing installation -- NC configuration -- creation -- by considering the conditions of the wearing person of a spectacle lens before a process, and creating the data for NC processing for every spectacle lens for processing, the customized spectacle lens suitable for each user can be manufactured completely, and can be offered

[0028] moreover, the configuration of the field for [of the semi finish lens which serves as a candidate for processing while choosing the semi finish lens suitable for processing it by beginning to delete based on the data for NC processing] processing -- measuring -- the data for NC processing -- an amendment -- the data [be / suitable / for processing / which considered the error of a semi finish lens etc. / it by actually deleting and carrying out appearance / it] for NC processing can create, and it can process based on it by things

[0029] moreover, NC configuration of the manufacture method of the spectacle lens of this invention -- creation -- a process can process it by deleting and carrying out appearance so that maximum surface roughness Rmax of the field where appearance was deleted and carried out and processing was performed may be set to 0.010mm or less It becomes possible to manufacture a spectacle lens with the desired optical surface for a short time, without making superfluously into a long time time which a polish process takes though a polish process will be carried out without carrying out a subsequent sand credit process, if this condition is used. In addition, if maximum surface roughness Rmax of the field where it began to delete at NC configuration generating process, and processing was performed is made small to an optical-surface grade, the polish process itself can also be made unnecessary by coming out as it is or performing hard coating after that.

[0030] moreover, the manufacture method of the spectacle lens of this invention -- NC configuration -- creation -- after processing it by deleting and carrying out appearance so that maximum surface roughness Rmax of a processed field may be set to 0.001mm or more and 0.010mm or less at a process, it imitates and polish can perform polish of the field if this condition is used -- NC configuration -- creation -- it becomes possible to manufacture a spectacle lens with a sufficient configuration precision with the desired optical surface and sufficient appearance precision for a short time, without making into a long time superfluously time which a process takes if it sets to have set maximum surface roughness Rmax to 0.001mm or more to less than 0.001mm here -- NC configuration -- creation -- it is because the time which a process takes becomes long superfluously In this case, it is desirable to be referred to as 0.002mm or more, and it is more desirable to be referred to as 0.003mm or more.

[0031] moreover, NC configuration of the manufacture method of the spectacle lens of this invention -- creation -- in case it is processed by deleting a process and carrying out appearance, the amount of level differences near [which is generated by the processed field] the point of inflection can process it by deleting and carrying out appearance so that it may be set to 0.005mm or less except for a field relative

roughness component For a long time, a bird clapper does not have the time which a polish process takes though a polish process will be carried out without carrying out the sand credit process for removing a level difference, if this condition is used, and it becomes possible [manufacturing a spectacle lens with the desired optical surface for a short time]. Having set the amount of level differences to 0.005mm or less here When a sand credit process is skipped after considering as the range exceeding 0.005mm, It is because it is in the inclination for the time which a polish process takes to become long and is not desirable. It is difficult to remove this level difference completely, even if it carries out a prolonged polish process. passing through a prolonged polish process, though this level difference is still able to be removed completely -- a configuration -- creation -- it is because the configuration precision of the optical surface by which creation was carried out at the process is worsened or polish sagging is generated Moreover, since a sand credit process can be skipped, it is effective in the ability to make unnecessary the polish pan which was required of the sand credit process.

[0032] Moreover, after the manufacture method of the spectacle lens of this invention processes it by beginning to delete so that the amount of level differences near [which is generated in case it is processed by beginning to delete] the point of inflection may be set to 0.0005mm or more and 0.005mm or less except for a field relative roughness component, it imitates and can perform polish of the field by polish. if this condition is used -- expensive, very small NC configuration of generating of a level difference -- creation -- it is not necessary to use equipment and a manufacturing cost can be reduced moreover -- since it is not necessary to make processing speed late in order to suppress generating of a level difference -- NC configuration -- creation -- it becomes possible to manufacture a spectacle lens with a sufficient configuration precision with the desired optical surface and sufficient appearance precision for a short time, without making into a long time superfluously time which a process takes

[0033]

[Embodiments of the Invention] The manufacture method of a spectacle lens and equipment which are applied to this invention in the spectacle lens made from plastics at an example are explained. The prescription data 100 obtained from the customer as a block diagram was used and shown in drawing 1 are transmitted to the host computer 101 of a lens maker's manufacturing department. Generally in the case of a progressive multifocal lens, S frequency, C frequency, an astigmatism shaft, the degree of subscription, prism, lens thickness, the diameter of a lens, a color, etc. are contained in this prescription data. Moreover, in the case of a single focal lens, prescription data, such as S frequency, C frequency, an astigmatism shaft, prism, lens thickness, a diameter of a lens, and a color, are contained, and it is transmitted to the host computer 101 of a direct lens maker's manufacturing department with online from the terminal with which the spectacles retail store was equipped with these prescription data 100. Or a relay base receives the prescription data 100 from a retail store with transmission meanses, such as a telephone and facsimile, and online transmission is carried out from this relay base. And based on the prescription data 100 transmitted to these host computers 101, in the calculation process 102, the above-mentioned prescription data are processed into the manufacture data for production lines by calculating computer, based on this manufacture data, calculation of the combination of a curved surface based on prescription of a customer in jamming is performed, and a lens configuration is designed for every prescription of a customer. This calculation process 102 is equipped with the function as a data generation process for processing for NC processing. The numerical-control cutting machine shown in drawing 2 used at the configuration generating process 106 of explaining below, Or the data for NC

processing for generating a lens design configuration with the numerical-control lathe-turning machine shown in drawing 3 (1st data for NC processing), and the numerical-control grinder shown in drawing 5 -- a configuration -- creation -- the data for NC processing for grinding the curved surface by which creation was carried out at the process (2nd data for NC processing) -- further It imitates, and calculation is performed simultaneously and the polish conditions of a grinder are also stocked by the storage which is shown in drawing 4 and by which the calculating computer was equipped with these.

[0034] Then, the semi finish lens which becomes the origin which processes the lens which is satisfied [with the lens selection process 103 which chooses a semi finish lens] prescription of a customer is selected. At the process 103 which chooses this semi finish lens, the corresponding semi finish lens is picked manually, or it picks automatically using an automatic warehouse etc.

[0035] although it is manufactured by cast molding using a mold as Naka of the conventional technology has also described the semi finish lens, even if it fabricates with the same type, the configurations differ for every semi finish lens on polymerization conditions, annealing conditions, etc., and the configuration of a mold may fully be unable to be imprinted depending on the case in such a case, it is alike occasionally, it carries out and the configuration precision of a desired semi finish lens is not acquired For this reason, the measurement necessity judgment process 104 of a semi finish lens is established, the configuration of the semi finish lens chosen at measurement and the calculation process 105 is measured beforehand, and the criteria curve for obtaining desired lens frequency from this measurement result is computed by calculating computer, and is fed back to calculation of the curved surface which generates. By establishing the process 105 which performs such amendment, the configuration error of a semi finish lens is canceled, and in order to obtain desired lens frequency as a result, it becomes possible to obtain the curved surface which should be carried out creation. The field of the field which carries out configuration measurement to carry out configuration generating among the concavo-convex sides of the selected semi finish lens is good only in respect of a reverse side in that case. If a measuring plane is the semi finish lens which carried out the spherical-surface configuration as the method of configuration measurement, radius of curvature can be easily measured by cross-section profile and form tester like tradename:Form Talysurf made from rank tailor HOBUSON. Moreover, when a field to measure has a sculptured surface like a progressive side, it is possible to perform configuration measurement using a profile and form tester, a three-dimensions measuring instrument, etc. using the interferometer.

[0036] In addition, when the configuration precision of a semi finish lens is stable, it can judge at the necessity judgment process 104, and the measurement process (amendment process) 105 can be made unnecessary. If the case where a measuring plane is the spherical surface is taken for an example, the radius of curvature of the spherical surface of the semi finish lens in the same manufacture lot, i.e., the standard deviation of a curve, is below the quadrant of lens frequency tolerance, and, as for this stable configuration precision, the difference of the average of a curve and a nominal curve makes the standard 1/5 or less [of frequency tolerance]. Moreover, when a measuring plane is a sculptured surface, this idea can be applied and a standard can be set up.

[0037] Next, a field configuration is generated according to the data for NC processing generated based on the prescription data of the user of each [the configuration generating process (NC processing process) 106], when polish is needed further at the process 107 which judges polish necessity, the polish process 108 is performed, finally inspection is conducted by the inspection process 109, and a spectacle lens is manufactured through these processes.

[0038] Below, it explains in more detail about 106 or less configuration generating process. first, a configuration -- creation -- the configuration which set to the chuck 202 of the numerical-control cutting machine 200 of the spectacle lens manufacturing installation 150 which shows the semi finish lens chosen at the semi finish lens selection process 103 to drawing 2 at a process 106, and was stocked by the storage of the calculating computer 101 -- the data for NC processing for creation (1st data for NC processing) -- the numerical-control cutting machine 200 -- transmitting -- a configuration -- creation is performed usually -- since the data for NC processing serve as the huge amount of data, or it once memorizes to the storage of the numerical-control cutting inside of a plane -- the data for NC processing -- direct -- a numerical-control cutting machine -- sending in -- a machine -- moving -- a configuration -- creation is performed in addition, a configuration -- even if it uses an others and numerical-control grinding machine and a numerical-control lathe-turning machine as a means of creation -- an equivalent configuration -- creation is possible [machine / numerical-control cutting / aforementioned]

[0039] In addition, if the edge implement used with these configurations generating means is cutting, a diamond cutter, a superhard cutter, etc. are grinding processes and a metal bond, the diamond wheel of electrodeposition, etc. are cutting processes by turning, a diamond and the byte of superhard ** will be mentioned. these configurations -- creation -- the configuration using the means -- creation -- at a process, roughing and finish-machining are performed by the one chuck, and make 0.01-below 10 [mum] to the surface roughness of the work after processing in finish-machining at maximum surface roughness Rmax (it considers as Following Rmax) Moreover, it is as having been shown in drawing 1 that the polish process 108 can be formed in the following process if needed, and a desired optical surface can be obtained. Although based also on the material of a plastic lens, it is Rmax about this surface roughness. Below 0.05 [mum], then in the case of the spectacle lens made from plastics, even if it skips the polish process 108, a desired optical surface can be obtained by performing surface treatment at the hard-coat process (un-illustrating) following the configuration generating process 106. In addition, even when surface roughness is the same, it is greatly influenced by the plastic-lens material whether a desired optical surface can be obtained by performing surface treatment at a hard-coat process.

[0040] the case where a desired optical surface cannot be obtained only by performing surface treatment at a hard-coat process on the other hand -- a configuration -- after creation -- the polish process 108 -- preparing -- a configuration -- creation -- a smooth optical surface is ground and made to a next lens front face 2nd NC processing process by the numerical-control grinder 500 which is specifically shown in drawing 4 and which it imitates and is shown in a grinder 400 or drawing 5 -- carrying out -- a configuration -- creation -- it grinds to a desired optical surface, without breaking down the curved-surface configuration by which creation was carried out at the process 106 Although these polishes means has equipped the polisher head which has elasticity The nonwoven fabric which has the length of hair about [which used rayon, nylon, etc. as the raw material] length 0.1-5 [mm] is allotted to the front face of a polisher head. further aluminum 2O3 It is also possible to raise polish efficiency by pouring water between the work for polish and the aforementioned nonwoven fabric in the polish liquid which considered as the principal component of an abrasive and mixed an oxide, water, etc. to this.

[0041] (Example 1) Below, each process and each equipment are explained to an example for the case where the inside successive promotion multifocal lens which is proposed by Japanese Patent Application No. 7-306189 and which has the curved surface which combined the progressive side and the toric side in the concave surface side of a lens is manufactured, in more detail. The diameter 80 of a lens [mm], +2.00

spherical degree (S frequency) [D], the astigmatism frequency (C frequency) [D] -1.75, 55 astigmatism shafts, the degree 2.25 of subscription [D], and the personal information of a user (customer) called prism 1.20 down are included in the prescription data 100 of this example. First, in order to satisfy the aforementioned prescription, the progressive side of a base curve 4.00 [D] and the degree 2.25 of subscription [D] which generates to the concave surface side of a lens, and the toric side which sees from a lens concave surface side in the astigmatism frequency -1.75 [D], and has a base curve shaft in the counterclockwise direction in the direction of 35 degrees to the main meridian of a progressive side calculated the curved surface compounded by the concave surface whole surface by calculating computer. Under the present circumstances, the result center thickness of a lens was also calculated simultaneously and the result was 3.35 [mm]. The data for NC processing for processing the curved surface calculated above following these calculation with the numerical-control cutting machine 200 shown in drawing 2 are created by calculating computer at the calculation process 102, and are recorded on the hard disk with which the calculating computer is equipped.

[0042] Next, although the semi finish lens for obtaining the inside successive promotion multifocal lens which satisfies the aforementioned prescription chose at the selection process 103, in this example, it has the spherical surface in a convex side, and the radius of curvature chose the semi finish lens which has the base curve of nominal value 6.00 [D] by 110.333 [mm]. The refractive index of the lens material of a semi finish lens is 1.662. Moreover, dispersion in the base curve in the inside of the same manufacture lot with which the selected semi finish lens is contained is as small as 0.005 [D] at standard deviation, and configuration precision was extremely stable. Moreover, the average of a base curve has the very small difference of 5.998 [D] and a nominal base curve. For this reason, correction of the lens design configuration which judged that the configuration measurement process 105 was unnecessary at the configuration necessity judgment process 104, and was calculated by calculating computer is not directed. In addition, the composition of the manufacture lot of the aforementioned semi-finish lens is 30 sheet / lot.

[0043] Then, at the configuration generating process 106, a semi finish lens is grasped by the work chuck 202 of the numerical-control cutting machine 200, the DNC operation mode of the numerical-control cutting machine 200 is used, and configuration generating of the lens design configuration is carried out by cutting, transmitting the aforementioned data for NC processing to the numerical-control cutting machine 200 directly from a host computer 101. the composition of the numerical-control cutting machine 200 of this example -- the time -- 2 -- being shown -- having -- as -- Horizontally mostly straight-line positioning The edge implement rotation means 213 mostly attached on a Y-axis positioning means 208 intersect perpendicularly with the X-axis positioning means 205 and the aforementioned X-axis positioning means 205 to perform mostly to perform straight-line positioning horizontally, a Z-axis positioning means 212 to perform straight-line positioning in the perpendicular direction, and the aforementioned Z-axis positioning means 212, It consists of work shaft rotation meanses 216 in which angle indexing is possible. It is established by the key objective that the Z-axis positioning means 212 doubles the heart quantity of a circular cutter 215 with a work 201. The main coordinate of a circular cutter 215 is positioned in the direction of a normal formed at the point processing [work] using three shafts of the X-axis positioning means 205, the Y-axis positioning means 208, and the work shaft rotation means 216. the configuration based on the lens design configuration by performing positioning of the main coordinate of the circular cutter 215 corresponding to this processing point continuously -- creation is performed

[0044] As for the minimum positioning accuracy of the numerical-control cutting machine 200 used for this example, the straight-line positioning means of 0.1[mum] work shaft rotation means is 0.001 [**]. moreover, a work radial delivery pitch -- the angle division pitch of 0.5 [mm/rotation] and a work hoop direction -- 1 round -- 360 -- dividing -- the amount 3.0 of finishing slitting [mm], and an edge implement -- a diameter 70.2 [mm] -- the superhard cutter of a two-sheet edge -- an edge implement rotation means -- 15000[-- r. -- it was made to rotate by p.m] and was used Sufficient configuration precision for the configuration of the curved surface by which cutting was carried out also to this condition to satisfy prescription was acquired.

[0045] the numerical-control cutting machine 200 -- a configuration -- creation -- the surface roughness of the spectacle lens obtained by the case where it uses for a process 106 -- Rmax Only by 4.5 [mum] and cutting, when an optical surface required for a lens is not obtained, polish processing 105 is carried out continuously. this example shows to drawing 4 among the spectacle lens manufacturing installations 150 -- imitating -- a grinder 400 -- using -- the aforementioned configuration -- creation -- the curved surface by which creation was carried out at the process is ground It is possible to generate a pressure required for polish between a work 401 and the polisher head 410 by load addition means by which imitate, and consist of an irrigation means 409 to pour water, and the rocking shaft which rocks as an equipment configuration of a grinder 400 in the work axis of rotation 403, the polisher axis of rotation 407, and the direction shown in an arrow 408 although not illustrated, polish liquid, etc. are not illustrated. The polisher head 410 consists of the sheets 404 and the polisher head cases 405 which have flexibility, such as rubber, and liquids, such as gases shown in the space where it was sealed between this sheet 404 and the polisher head case 405 406, such as the compressed air, or water, are made to press fit, and it is blowing up a sheet 404 by the pressure, and it becomes possible to imitate arbitrary work configurations. adding rocking operation with the aforementioned rocking shaft, while rotating the work axis of rotation 403 and the polisher axis of rotation 407, and pouring water in polish liquid from the irrigation means 409 in the state where the swollen sheet 404 imitates the configuration of a work 401, -- the aforementioned configuration -- creation -- it becomes possible to grind to a desired optical surface, without breaking down the work configuration by which creation was carried out at the process Moreover, it is also possible to stick the abrasive cloth which is not illustrated on the front face of a sheet 404 according to the material of the work for polish, and to improve a polish performance further.

[0046] the basis of this composition -- the space where it was sealed between the sheet 404 and the polisher head case 405 while sticking on the front face of a sheet 404 with adhesives the nonwoven fabric which has the length of hair of the length 0.8 [mm] which uses rayon as a raw material, although not illustrated in this example -- the compressed air 406 of about 3.2 [kgf/cm2] -- sending in -- a configuration -- creation -- the sheet 404 was blown up so that a sheet 404 might imitate mostly the curved surface by which creation was carried out at the process Furthermore, the pressure of about 32.5 [kgf/cm2] was generated between the work 401 and the polisher head 410 using the load addition means which is not illustrated. this state -- the polisher head shaft 407 -- about 100 [-- r. -- p.m] and the work shaft 403 -- about 5 [-- r. -- it rotates by p.m] -- making -- in addition -- and rocking operation of six round trips was added per minute with the rocking means which is not illustrated In addition, between working [of these series], the work 401, and the polisher head 410, water was poured from the irrigation means 409 in polish liquid 411 (Fujimi tradename : poly plastic 103A). a part for consequently, about 10 [--] -- the required optical surface was able to be obtained Since polish processing was carried out without breaking

down most configurations at the time of the aforementioned configuration generating, moreover, the measured value at the time of dimension inspection The diameter 80.09 of a lens [mm], the S frequency +2.02 [D], the C frequency -1.77 [D], the astigmatism shaft 55 [**], the degree 2.25 of subscription [D], prism 1.17 down, and result center thickness 3.31 [mm], Any measured value fulfills the specification value and the inside successive promotion multifocal lens which fully satisfies prescription was able to be obtained.

[0047] In addition, the numerical-control cutting machine shown in drawing 2 is usable also as a numerical-control grinding machine by changing the edge implement to be used into grinding stones for grinding, such as a metal bond, from a circular cutter 215, and can obtain a configuration precision equivalent to a numerical-control cutting machine, and surface roughness.

[0048] Moreover, even if it transposes to the numerical-control lathe-turning machine 300 which shows the numerical-control cutting machine 200 to drawing 3 , the almost same result can be obtained. The numerical-control lathe-turning machine 300 consists of a Y-axis positioning means 308 to perform straight-line positioning horizontally and the work shaft rotation means 306, in which angle indexing is possible of intersecting perpendicularly with an X-axis positioning means 305 to perform straight-line positioning horizontally mostly, and the aforementioned X-axis positioning means 305, mostly, and tool post 311. A numerical-control lathe-turning machine positions the main coordinate at a byte's 307 nose of cam R like the aforementioned numerical-control cutting machine in the direction of a normal formed at the processing point of a work 301 using three shafts of the X-axis positioning means 305, the Y-axis positioning means 308, and the work shaft rotation means 306. the configuration based on the lens design configuration by performing positioning of the main coordinate at the nose of cam R of the byte 307 corresponding to this processing point continuously -- creation is performed under the present circumstances, the work 301 -- a configuration [of a work], roughness, and finish-machining exception -- 100 - 2000[-- r. -- it rotates by the work shaft rotation means 306 at the rotational frequency between p.m]

[0049] Moreover, although it imitated at the polish process 108 and the grinder 400 was used in this example, even if it uses the numerical-control grinder 500 shown in drawing 5 and grinds using the data for NC processing for polish (2nd data for NC processing), it cannot be overemphasized that the almost equivalent result is obtained. As the numerical-control grinder 500 is shown in drawing 5 Horizontally mostly straight-line positioning A Y-axis positioning means 507 intersect perpendicularly with the X-axis positioning means 505 and the aforementioned X-axis positioning means 505 to perform mostly to perform straight-line positioning horizontally, the rotary table 503 which has an angle indexing function, four shafts of an R shaft positioning means 504 to have an angle indexing function, Or it is based on the aforementioned X-axis positioning means 505, the aforementioned rotary table 503, and the data for NC processing beforehand calculated from the design configuration of three shafts of the aforementioned R shaft positioning means 504, and a lens. Perform the relative-position arrangement with the polisher head 510 and a work 501, and parts with arbitrary medial axis of the polisher head 510 or front face of the polisher head 510 are made in agreement in the direction of a normal in the processing point of a work 501. From the direction, with the load addition means 513, the polisher head 510 is pressed and polish processing is carried out. Grinding to a desired optical surface is possible, without breaking down the curved-surface configuration by which creation was carried out by this at the configuration generating process 106.

[0050] (Example 2) Next, the example in the case of manufacturing the progressive multifocal lens which

has a progressive side by the manufacture method of this invention is explained to the convex side of a lens using a drawing.

[0051] Data called the diameter 80 of a lens [mm], -3.25 spherical degree (S frequency) [D], the astigmatism frequency (C frequency) [D] -0.75, 90 astigmatism shafts, the degree 1.00 of subscription [D], and down prism 0.75 are contained in the prescription data 100 of this example. In order to satisfy this prescription, the toric side of a base curve 5.75 [D] and a cross curve 6.50 [D] which generates to the concave surface side of the semi finish lens chosen at the semi finish lens selection process 103 was calculated using the calculating computer at the calculation process 102. Under the present circumstances, it was 1.55 [mm] when the result center thickness of a lens was also calculated simultaneously. Then, the data for NC processing for processing it with the numerical-control lathe-turning machine 300 which shows the calculated toric side to drawing 3 were created by calculating computer, and it recorded on the hard disk with which the calculating computer 101 is equipped.

[0052] Next, although the semi finish lens for obtaining the progressive multifocal lens which is satisfied [with the semi finish lens selection process 103] of the aforementioned prescription was chosen, in this example, criteria radius of curvature chose as the convex side the semi finish lens of the refractive index 1.662 which has the nominal value 2.50 [D] base curve of 264.8 [mm], and the progressive side of the degree 1.00 of subscription [D]. As for dispersion in the base curve in the inside of the same manufacture lot with which the selected semi finish lens is contained, as greatly as 0.072 [D], 2.551 [D] and since the average of a base curve had an unstable configuration precision, it judged that measurement was required at the measurement necessity judgment process 104, and performed configuration measurement with the three-dimensions measuring instrument at the measurement process 105 at standard deviation. The base curve of the semi finish lens used for this example was 2.542 [D] as a result of measurement. therefore, 0.042[which is the difference of 2.50 [D] which is a nominal base curve -- in order to generate the toric side which corrected a part for D], it re-calculated by calculating computer, and it asked for the data for NC processing Under the present circumstances, although the result center thickness of a lens was also re-calculated simultaneously with the data for NC processing, about result center thickness, it was the same numeric value as re-calculation before. In addition, the composition of the manufacture lot of the aforementioned semi-finish lens is 20 sheet / lot.

[0053] Then, it grasped by the work chuck 302 of the numerical-control lathe-turning machine 300 which shows the aforementioned semi-finish lens to drawing 3 , and the DNC operation mode of a numerical-control lathe-turning machine was used, and configuration generating was carried out by the cutting process by turning, transmitting directly the data for NC processing memorized by the aforementioned host computer 101 to the numerical-control lathe-turning machine 300. In addition, although the composition of the numerical-control lathe-turning machine 300 is as the example 1 having described, as for the minimum positioning accuracy of the numerical-control lathe-turning machine used for this example, the straight-line positioning means of 0.1[mum] work shaft rotation means is 0.01 [**]. moreover, a byte's 307 nose of cam R -- 4.0 [mm] and a work rotational frequency -- 750[-- r. -- in the p.m] and work radial delivery pitch, the angle division pitch of 0.01 [mm/rotation] and a work hoop direction divided 1 round into 360, and the amount of finishing slitting was 2.0 [mm]

[0054] Sufficient configuration precision for the configuration of the aforementioned toric side by which the cutting process by turning was carried out also to this condition to satisfy prescription was acquired. Furthermore, surface roughness is Rmax. Since the optical surface required only of 0.014 [mum] and a

cutting process by turning was obtained, it was judged as polish needlessness at the polish necessity judgment process 107, and the polish processing 108 was omitted. However, since it had not resulted in the optical surface of level which can conduct dimension inspection with a lens meter, dimension inspection was conducted after giving hard-coat processing. As a result, the diameter 79.96 of a lens [mm], the S frequency -3.26 [D], the C frequency -0.77 [D], the astigmatism shaft 90 [**], the degree 0.98 of subscription [D], the down prism 0.75, result center thickness 1.53 [mm], and any measured value fulfill the specification value, and the measured value at the time of inspection was able to obtain the progressive multifocal lens which fully satisfies prescription.

[0055] in addition -- this example -- a configuration -- although the numerical-control lathe-turning machine 300 was used as a means of creation -- an example 1 -- the same -- the numerical-control cutting machine 200 or a numerical-control grinding machine -- using -- a configuration -- even if it performs creation, it cannot be overemphasized that an almost equivalent result is obtained However, depending on the size of the surface roughness after configuration generating processing, it may imitate like an example 1, and polish processing with a grinder 400 or the numerical-control grinder 500 may be needed.

[0056] Although it is rare, when dispersion in the base curve of a semi finish lens uses greatly the manufacture lot with which a semi finish lens with the large gap from a nominal base curve is contained so much like this example, the direction of the time and effort of a re-calculation which replaced the turn of the calculation process 102 of the block diagram of drawing 1 and the semi finish lens selection process 103, and performed lens manufacture may be lost, and efficiency may improve.

[0057] (Example 3) It continues, and by the manufacture method of the spectacle lens of this invention, configuration generating of the progressive side is carried out at the convex side of a semi finish lens, and the example in the case of manufacturing a desired progressive multifocal lens is explained using a drawing.

[0058] The data of diameter 70 of lens [mm], -10.50 spherical degree (S frequency) [D], degree 1.50 of subscription [D], and prism 2.00 rise are contained in the prescription data 100 of this example. For this reason, in order to satisfy prescription, in the calculation process 102, the progressive side of a base curve 1.00 [D] and the degree 1.50 of subscription [D] which generates to the convex side of a semi finish lens was calculated by calculating computer. Under the present circumstances, it was 1.05 [mm] when the result thickness of a lens was also calculated simultaneously.

[0059] In addition, in this example, it changed into the metal-bond diamond wheel which does not illustrate the circular cutter 215 of the numerical-control cutting machine 200 shown in a view 2 as a configuration generating means, and was used as a numerical-control grinding machine.

[0060] Then, at the calculation process 102, the data for NC processing for processing the progressive side calculated above with the aforementioned numerical-control grinding machine were created by calculating computer, and it recorded on the hard disk with which the calculating computer is equipped.

[0061] Next, although the semi finish lens for obtaining the progressive multifocal lens which is satisfied [with the semi finish lens selection process 103] of the aforementioned prescription was chosen, in this example, the semi finish lens which has the spherical surface and with which the radius of curvature has the base curve of nominal value 11.50 [D] by 57.565 [mm] was chosen as the concave surface side. The refractive index of the lens material of a semi finish lens is 1.662. Moreover, dispersion in the base curve in the inside of the same manufacture lot with which the selected semi finish lens is contained was as small as 0.002 [D] at standard deviation, and configuration precision was extremely stable. Moreover,

since the average of a base curve had the very small difference of 11.492 [D] and a nominal base curve value, the above-mentioned configuration measurement was unnecessary like the example 1. Therefore, correction of the lens design configuration calculated above was unnecessary. In addition, the composition of the manufacture lot of the aforementioned semi-finish lens is 30 sheet / lot.

[0062] Then, in the configuration generating process 106, configuration generating of the lens design configuration was carried out by the grinding process at the convex side of the aforementioned semi-finish lens, having grasped by the work chuck by which a numerical-control grinding machine does not illustrate the aforementioned semi-finish lens, having used the DNC operation mode of a numerical-control grinding machine, and transmitting the aforementioned data for NC processing to a numerical-control grinding machine directly. The composition of a numerical-control grinding machine is the same as a numerical-control cutting machine, if the difference in an edge implement is removed. As for the minimum positioning accuracy of the numerical-control grinding machine used for this example, the straight-line positioning means of 0.1[mum] work shaft rotation means is 0.001 [**]. moreover, a work radial delivery pitch -- the angle division pitch of 0.75 [mm/rotation] and a work hoop direction -- 1 round -- 360 -- dividing -- the amount of finishing slitting -- 0.2 [mm] and an edge implement -- a diameter 68.2 [mm] -- the metal-bond diamond wheel of 500 meshes -- an edge implement rotation means -- 10000[-- r. -- it was made to rotate by p.m] and was used Sufficient configuration precision for the configuration of the curved surface by which the grinding process was carried out also to this condition to satisfy prescription was acquired. However, surface roughness is Rmax. An optical surface required for a lens was not obtained only by 6.2 [mum] and the grinding process.

[0063] For this reason, polish processing 108 was given continuously. In this example, the curved surface which is shown in <u>drawing 4</u> and by which imitated and configuration creation was carried out using the grinder was ground. It imitates and the equipment configuration of a grinder is as the example 1 having explained. In this example, although not illustrated, while sticking on the front face of a sheet 404 with adhesives the nonwoven fabric which has the length of hair of the length 0.8 [mm] which uses rayon as a raw material, the sheet 404 was blown up so that the compressed air 406 of about 2.4 [kgf/cm2] might be sent into the space where it was sealed between the sheet 404 and the polisher head case 405 and a sheet 404 might imitate mostly the curved surface by which configuration creation was carried out. The pressure of about 26.9 [kgf/cm2] was generated between the work 401 and the polisher head 410 using the load addition means which furthermore is not illustrated. this state -- the polisher head shaft 407 -- about 120 [-- r. -- p.m] and the work shaft 403 -- about 5 [-- r. -- it rotates by p.m] -- making -- in addition -- and rocking operation of three round trips was added per minute with the rocking means which is not illustrated In addition, between working [of these series], the work 401, and the polisher head 410, water was poured from the irrigation means 409 in polish liquid 411 (Fujimi tradename : poly plastic 103A). a part for consequently, about 13 [--] -- the required optical surface was able to be obtained Moreover, since polish processing was carried out without breaking down most configurations at the time of the aforementioned configuration generating, the diameter 70.06 of a lens [mm], the S frequency -10.46 [D], the degree 1.50 of subscription [D], prism 1.92 rise, result center thickness 1.11 [mm], and any measured value fulfill the specification value, and the measured value at the time of dimension inspection was able to obtain the progressive multifocal lens which fully satisfies prescription.

[0064] As explained above, according to the manufacture method of the spectacle lens of this example, and the manufacturing installation Based on prescription of a customer, calculate the combination of a curved

surface, and processing data are computed. The creation of the curved surface of all the combination [means / polish / a cutting means to generate a desired curved surface or a grinding means, a lathe-turning means, a means to compute the criteria data for measuring the configuration of a semi finish lens further in addition to these, and obtaining desired frequency, and] according to prescription is possible. consequently, the processing pan made indispensable with the conventional technology and a lot of molds for molding not only become unnecessary, but It becomes possible to manufacture a spectacle lens various type easily and to supply by the low cost. The cast-molding method of not only the conventional progressive multifocal lens but the conventional technology takes immense cost and immense time. Moreover, by the manufacture method by polish processing, it has great effects -- the inside successive promotion multifocal-glasses lens which cannot be manufactured and which was indicated by Japanese Patent Application No. 7-306189 can also be actually offered by short time for delivery and a short low cost.

[0065]

[Effect of the Invention] Thus, it is made to manufacture by NC processing based on the data for NC processing in this invention unlike the manufacture method which combined the field [by the side of the body of a spectacle lens], or field by the side of eyeball polish-equipment using casting molding, a conventional curve generator, and a conventional processing pan, or these. For this reason, it can manufacture only by changing the data for NC processing using the manufacturing installation in which the spectacle lens equipped with what curved surface was also common, or the manufacturing installation of a few kinds. Therefore, in this invention, by the conventional manufacture method, it becomes possible to supply actually the inside successive promotion multifocal lens which cannot be supplied completely, and the spectacle lens equipped with a different field for every wearing person of a spectacle lens can be offered at suitable time for delivery and a suitable price. moreover, only changing the data for NC processing by using the manufacture method of this invention, and a manufacturing installation -- a variety -- since a busy spectacle lens can be manufactured -- beforehand -- a variety -- a busy processing pan is manufactured and it becomes unnecessary to manage them Therefore, not only an inside successive promotion multifocal lens but a spectacle lens various type can be supplied by the low price, and it becomes possible to also shorten the time for delivery sharply.

[Translation done.]

* NOTICES *

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram showing the manufacturing process of the spectacle lens in this invention.

[Drawing 2] Front view showing the numerical-control cutting machine of the spectacle lens manufacturing installation of this invention.

[Drawing 3] The plan showing the numerical-control lathe-turning machine of the spectacle lens manufacturing installation of this invention.

[Drawing 4] Front view in which the spectacle lens manufacturing installation of this invention imitating, and showing a grinder.

[Drawing 5] Front view showing the numerical-control grinder of the spectacle lens manufacturing installation of this invention.

[Drawing 6] The manufacture range table showing the general manufacture range of a spectacle lens.

[Description of Notations]

101 Host Computer

102 Calculation Process

103 Semi Finish Lens Selection Process

104 Measurement Necessity Judgment Process of Semi Finish Lens

105 Measurement and Calculation Process of Semi Finish Lens

106 Configuration Generating Process

107 Polish Necessity Judgment Process

108 Polish Process

109 Inspection Process

201 Work

202 Work Chuck

203 Motor for Work Axis-of-Rotation Drive, and Encoder

204 Work Axis of Rotation

205 X-axis Positioning Means

206 Motor for X-axis Drive, and Encoder

207 Bed

208 Y-axis Positioning Means

209 Motor for Y-axis Drive, and Encoder

210 Z-axis Column

211 Motor for Z-axis Drive, and Encoder
212 Z-axis Positioning Means
213 Edge Implement Rotation Means
214 Edge Implement Axis of Rotation
215 Circular Cutter
216 Work Shaft Rotation Means
301 Work
302 Work Chuck
303 Motor for Work Axis-of-Rotation Drive, and Encoder
304 Motor for X-axis Drive, and Encoder
305 X-axis Positioning Means
306 Work Shaft Rotation Means
307 Byte
308 Y-axis Positioning Means
309 Motor for Y-axis Drive, and Encoder
310 Bed
311 Tool Post
401 Work
402 Work Chuck
403 Work Axis of Rotation
404 Sheet Which Has Flexibility
405 Polisher Head Case
406 Liquids, Such as Gases, Such as Compressed Air, or Water
407 Polisher Head Center-of-Rotation Shaft
408 The Rocking Direction
409 Irrigation Means
410 Polisher Head
411 Polish Liquid
501 Work
502 Work Chuck
503 Motor and Rotary Table with a Built-in Encoder
504 R Shaft Positioning Means
505 X-axis Positioning Means
506 Motor for X-axis Drive, and Encoder
507 Y-axis Positioning Means
508 Bed
509 Motor for Y-axis Drive, and Encoder
510 Polisher Head
511 Polisher Head Rotation Means
512 Z-axis Positioning Means
513 Load Addition Means
514 Motor for Z-axis Drive, and Encoder

515 Lqad Transfer Shaft

[Translation done.]

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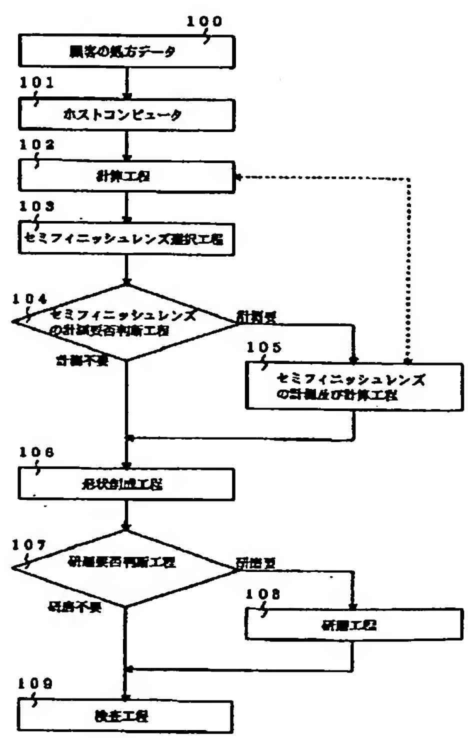
(54)【発明の名称】　眼鏡レンズの製造方法および製造装置

(57)【要約】

【課題】　従来技術では必須とされていた加工皿や多量の成型用型を不要とし、いわゆる内面累進多焦点眼鏡レンズをも短い納期と低コストで製造することのできる方法を提供する。

【解決手段】　処方を満足する曲面の組み合わせを計算してＮＣ加工用データを生成する計算工程１０２と、処方に対応するセミフィニッシュレンズを選択する工程１０３と、セミフィニッシュレンズの内面あるいは外面をＮＣ加工用データに基づいてＮＣ加工して所望の曲面形状に創成する工程１０６とを設け、ＮＣ加工によって眼鏡レンズの面を製造可能にすることにより、内面累進多焦点レンズも含めた多種多様な眼鏡レンズを低価格および短納期で製造可能にすることができる。



【特許請求の範囲】

【請求項1】　眼鏡レンズの物体側の面または眼球側の面の少なくともいずれか一方の面の削り出し加工を数値制御加工用データに基づいて行うＮＣ形状創成工程を有することを特徴とする眼鏡レンズの製造方法。

【請求項2】　請求項1において、前記ＮＣ形状創成工程で削り出し加工が行われた面の研磨を、倣い研磨により行う倣い研磨工程を有することを特徴とする眼鏡レンズの製造方法。

【請求項3】　請求項1において、前記ＮＣ形状創成工程で削り出し加工が行われた面の研磨を、研磨する面形状を規定した数値制御加工用データに基づいて行うＮＣ研磨工程を有することを特徴とする眼鏡レンズの製造方法。

【請求項4】　請求項1において、前記ＮＣ形状創成工程は、セミフィニッシュレンズの削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項5】　請求項1において、前記ＮＣ形状創成工程の前に、眼鏡レンズの装用者の条件を加味して加工対象の眼鏡レンズ毎に前記数値制御加工用データを作成する加工用データ作成工程を有することを特徴とする眼鏡レンズの製造方法。

【請求項6】　請求項5において、前記加工用データ作成工程に続いて、前記数値制御加工用データに基づいて削り出し加工を行うのに適したセミフィニッシュレンズを選択するセミフィニッシュレンズ選択工程を有し、前記ＮＣ形状創成工程では、前記セミフィニッシュレンズ選択工程で選択されたセミフィニッシュレンズの削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項7】　請求項4または6において、前記ＮＣ形状創成工程の前に、削り出し加工対象となるセミフィニッシュレンズの加工対象の面の形状を計測し、前記数値制御加工用データを補正する補正工程を有することを特徴とする眼鏡レンズの製造方法。

【請求項8】　請求項1において、前記ＮＣ形状創成工程は、削り出し加工が行われた面の最大表面粗さＲｍａｘが０．０１０mm以下になるように削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項9】　請求項2において、前記ＮＣ形状創成工程は、削り出し加工が行われた面の最大表面粗さＲｍａｘが０．００１mm以上かつ０．０１０mm以下になるように削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項10】　請求項1において、前記ＮＣ形状創成工程は、削り出し加工が行われる際に生成される変曲点近傍の段差量が、面粗度成分を除いて、０．００５mm以下になるように削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項11】　請求項2において、前記ＮＣ形状創成工程は、削り出し加工が行われる際に生成される変曲点近傍の段差量が、面粗度成分を除いて、０．０００５mm以上かつ０．００５mm以下になるように削り出し加工を行うことを特徴とする眼鏡レンズの製造方法。

【請求項12】　眼鏡レンズの物体側の面または眼球側の面の少なくともいずれか一方の面の削り出し加工を行うための数値制御加工用データを記憶することができる記憶部と、眼鏡レンズをセットすることができる手段と、この眼鏡レンズの加工対象となる面の削り出し加工を数値制御加工用データに基づいて行うことができるＮＣ形状創成手段と、を有することを特徴とする眼鏡レンズの製造装置。

【請求項13】　請求項12において、前記ＮＣ形状創成手段で削り出し加工が行われた面の研磨を倣い研磨により行うことができる倣い研磨手段、を有することを特徴とする眼鏡レンズの製造装置。

【請求項14】　請求項12において、前記ＮＣ形状創成工程で削り出し加工が行われた面の研磨を、研磨する面形状を規定した数値制御加工用データに基づいて行うことができるＮＣ研磨手段を有し、前記記憶部は、削り出す面形状を規定した数値制御加工用データに加えて、前記ＮＣ研磨手段で研磨する面形状を規定した数値制御加工用データを記憶することができるものであることを特徴とする眼鏡レンズの製造装置。

【請求項15】　請求項12において、眼鏡レンズの装用者の条件を加味した数値制御加工用データを加工対象の眼鏡レンズ毎に前記記憶部に設定する加工データ設定手段を有することを特徴とする眼鏡レンズの製造装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、眼鏡レンズの製造方法及び装置に関するものである。

【0002】

【従来の技術】眼鏡レンズは、単焦点レンズと多焦点レンズに大別される。それぞれのレンズの一般的な製作範囲と在庫形態及び従来の製造方法について説明する。なお、以下では特にプラスチック製の眼鏡レンズについて説明を行う。

【0003】まず、単焦点レンズについて説明する。単焦点レンズは近視あるいは遠視患者の視力矯正のために用いられるが、その製作範囲の一例を図6に示す。球面度数（以下Ｓ度数とする）で－１５．００［Ｄ］から＋１０．００［Ｄ］程度の範囲を０．２５［Ｄ］ステップで、これに乱視度数（以下Ｃ度数とする）が０．２５［Ｄ］から６．００［Ｄ］程度の範囲で、Ｓ度数と同じく０．２５［Ｄ］ステップで設けられる。但し、Ｃ度数の範囲は第６図に示される例ではＳ度数が－９．００［Ｄ］を越えると段階的に減少していく。しかし、レンズの種類は第６図に示される製作範囲だけで２２２５種類にもなり、レンズの屈折率や設計によってはさらに広い製作範囲を有するものもある。

【０００４】次に在庫の形態だが、Ｓ度数－１０．００［Ｄ］から＋６．００［Ｄ］とＣ度数０．２５［Ｄ］～２．００［Ｄ］で囲まれる範囲は特に受注の多い部分で、フィニッシュレンズと呼ばれる成形レンズとして在庫するのが一般的である。フィニッシュレンズ以外の範囲は受注頻度が低いため、フィニッシュレンズとしては在庫せずに、仕上げ寸法よりも肉厚が厚く、数ステップ分の度数のレンズを製作することのできる、セミフィニッシュレンズと呼ばれる成形レンズ（以下セミフィニッシュレンズとする）として在庫する。

【０００５】次に単焦点レンズの製造方法を説明する。単焦点レンズは、レンズの物体側の面を規定するために凹面となった上型と、眼球側の面を規定するために凸面なった下型とを組み合わせ型にレンズ素材を注入して成形する注型成形によって製造される。フィニッシュレンズが所望の度数を得るために、Ｓ度数のみを有する球面レンズ（以下球面レンズとする）の場合は、上型の凹面に球面または回転対称非球面を設け、下型の凸面側に球面を設ける。一方、Ｓ度数に加えＣ度数を有する乱視レンズ（以下乱視レンズ）の場合は、上型の凹面側に球面または回転対称非球面を設け、下型の凸面側にトーリック面を設け、これらを組み合わせて注型成形によって製造される。成形後離型されたレンズは十分満足できる精度の光学面を有しているため、染色工程、ハードコート工程、蒸着工程等を経て完成レンズとなる。

【０００６】一方、セミフィニッシュレンズを加工してフィニッシュレンズにする製造方法もある。セミフィニッシュレンズはフィニッシュレンズの球面レンズの場合と同じく、上型および下型とを組み合わせ、仕上げ寸法よりも肉厚が厚くなるように注型成形によって製造される。前述の受注頻度の低い度数のレンズや、プリズム量やレンズの厚みを指定する特殊処方のレンズは、特別注文レンズとして扱われ、処方に応じて寸法の異なるレンズを製作する必要がある。この特別注文のレンズは、処方に応じて、球面レンズであればセミフィニッシュレンズの凹面側をほぼ所望の球面に、乱視レンズであればセミフィニッシュレンズの凹面側をほぼ所望のトーリック面形状となるように荒削りした後、ラッピング加工に似た砂掛け加工と研磨加工を施し、レンズの光学面を精密に仕上げる。この砂掛け工程と研磨工程では専用の治具に保持されたレンズを、予め形状あるいは曲率が定まった加工皿に載せ、ラップ材をレンズ加工面に注水しながらレンズと加工皿を相対的に摺り動かすことによりレンズ表面を加工する。砂掛け工程ではレンズ表面の凸凹を小さくし、また研磨工程では所望の外観が得られる精度まで仕上げる。この荒削り、砂掛け、研磨という一連の加工方法は総称して研磨加工と呼ばれている。

【０００７】前述のプリズム量やレンズの厚みを指定する特殊処方のレンズは、フィニッシュレンズの製造方法では製造できないものがあるため、フィニッシュレンズの製作範囲であってもセミフィニッシュレンズから製造する必要がある。よって、第６図に示される製作範囲を例にとれば、砂掛け、研磨加工に使用する加工皿は、レンズと同じ２２２５種類分の異なる形状あるいは曲率のものを事前に用意しておく必要がある。

【０００８】通常こうして得られたレンズは研磨レンズと呼ばれる。この研磨レンズは十分満足できる精度の光学面を有するため、フィニッシュレンズと同様に染色工程、ハードコート工程、蒸着工程等を経て完成レンズとなる。

【０００９】次に、前記研磨レンズを得るための製造装置について説明する。まず、荒削り加工を行う装置は、一定の曲率の面を削りだしできる、いわゆるカーブジェネレータやこれを発展させ擬似的なトーリック面も加工できるジェネレータが用いられ、処方に応じ、また後工程での加工しろを考慮した厚みで所望の形状に近い球面、あるいはトーリック面に研削または切削加工される。砂掛け加工と研磨加工を行う装置は基本的には同じ機構であり、いずれも加工皿とレンズを相対的に摺り動かす機構と、加工皿とレンズとの間に圧力を発生させる手段及びラップ材を供給する手段とを備えている。この機構については、例えば宇田川式と称されるレンズの三角運動と加工皿の回転を行うものや、ＡＯ式と称されるレンズの円運動と加工皿の回転を行うものが知られている。なお、加工の際は処方に応じて加工皿を選択する必要がある。また、レンズの材質や工程に応じてパッドの交換を行う。因みに、ガラス製眼鏡レンズも前記プラスチック製の眼鏡レンズの場合と同様に荒削り加工、砂掛け加工、研磨加工して製作するのが一般的である。

【００１０】続いて多焦点レンズについて説明する。多焦点レンズは累進多焦点レンズと多重焦点レンズとに分けられる。これら多焦点レンズは遠用視用の単焦点レンズの機能と近用視用の単焦点レンズの機能を一枚のレンズで実現するものである。

【００１１】よって、眼鏡を掛け替えることなく遠用視と近用視の視力矯正が可能で、掛け替えに伴う煩わしさが無い。

【００１２】累進多焦点レンズはレンズの外面側、つまりは凸面側に焦点距離が連続して変化する累進面を有することを特徴とし、多重焦点レンズはバイフォーカル（二重焦点）、トリフォーカル（三重焦点）といったタイプが商品化されており、レンズの外面側、つまりは凸面側に二つないしは三つの焦点距離を得るための曲面を有することを特徴とする。よって、多焦点レンズは単焦点レンズとは異なり、遠用視用の度数と近用視用の度数があるわけで、これら二つの度数の差の絶対値を加入度と呼ぶ。

【００１３】なお、以降は多焦点レンズの中でも現在主流の累進多焦点レンズを例に説明する。累進多焦点レンズの製作範囲であるが、Ｓ度数及びＣ度数の範囲は第６

図に示される製作範囲と通常同じである。これに加え累進多焦点レンズの場合は、前述の加入度が０．２５［D］ステップで０．５０［D］から３．５０［D］まで１３ステップ設けられるのが一般的である。また、最近では右目用レンズと左目用レンズをそれぞれ別々に設計することが一般化してきている。累進多焦点レンズの場合、単焦点レンズと同じ製作範囲であっても、この加入度と左右別設計の他、乱視処方レンズは、処方の乱視軸を累進面の主子午線を基準位置として、レンズ毎に１［°］ステップで１８０種類設定する必要があるため、前記製作範囲のレンズの種類は、乱視軸分も含めると９９４２９４６種類と膨大な数となるが、この中に前記のような特殊処方レンズは含まれない。

【００１４】次に累進多焦点レンズの製造方法だが、累進多焦点レンズは基本的に全数特別注文レンズであるため、凸面側に累進面を有するセミフィニッシュレンズから処方に応じて、前記単焦点レンズの研磨レンズの場合とほぼ同様の方法と装置で製造される。すなわち、眼鏡レンズの物体側の面（凸面側）が所定の性能の累進面となり、眼球側の面（凹面側）が仕上げ寸法よりも肉厚が厚くなるようにセミフィニッシュレンズが注型成形によって製造され、セミフィニッシュレンズの凹面側が、処方に応じて、球面レンズであれば所望の球面に、乱視レンズであれば所望のトーリック面形状となるように研磨加工する。このように、累進多焦点レンズで乱視処方の場合は凸面側の累進面の主子午線を基準位置とした乱視軸を凹面側に設定する必要があり、製造上この点が前記単焦点レンズの研磨レンズの場合と異なる。なお、加工皿は図６に示される製作範囲であれば、凹面側に創成される球面、トーリック面の種類の数が加工皿の種類の数となるので、単焦点レンズの場合と同じ２２２５種類となる。

【００１５】このように、累進多焦点レンズ用のセミフィニッシュレンズは、凹面側に累進面を有する上型と、凸面側に球面を有する下型とを組み合わせ、仕上げ寸法よりも肉厚が厚くなるように注型成形によって製造される。また、製作範囲の中で受注頻度の高いＳ度数と加入度を有するレンズは、凹面側に累進面を有する上型と、凸面側に球面を有する下型とを組み合わせ、注型成形によってフィニッシュレンズを製造する場合もある。しかしながら、一般的に累進多焦点レンズのフィニッシュレンズはごく少量であり、９５％以上はセミフィニッシュレンズとして在庫される。

【００１６】ところで、特別注文レンズの累進多焦点レンズでもフィニッシュレンズの製造比率を極限まで高めようという製造方法が特開平５－１９２１２に提案されている。この製造方法は特別注文レンズのほとんどを注型成形により製造するもので、累進多焦点レンズにもかかわらずフィニッシュレンズの製造比率は９０％を越えている。その製造方法は、予め製作範囲に対応した種類分の型を揃えておき、顧客の処方に応じて所望の度数を得るための上型と下型を選びこれを組み合わせ、注型成形することで処方を満足するレンズを得るというものである。

【００１７】具体的には、図６に示す製作範囲で加入度が前記と同じく１３ステップとすると、凹面側に累進面を有する上型の種類は製作範囲を５つのベースカーブ区分で区切り、左右別設計とした場合、その総数は１３０種類となる。また、前記１３０種類の上型と組み合わせて球面タイプの累進多焦点レンズを製造するために使われる、凸面側に球面を有する下型は１００種類、同様に乱視タイプの累進多焦点レンズを製造するために使われる、凸面側にトーリック面を有する下型は２１００種類、合計２４３０種類の型を揃えフィニッシュレンズを製造する。なお、乱視タイプの累進多焦点レンズの場合は、処方に応じて上型の累進面の主子午線を基準位置に下型の乱視軸を設定した後、注型成形する。なお、特殊処方のレンズと前記の製作範囲を越える度数のレンズについては、前記と同じくセミフィニッシュレンズから研磨加工により製造される。

【００１８】

【発明が解決しようとする課題】しかしながら、前記の背景技術に示した研磨加工による眼鏡レンズの製造方法では、第一に加工皿を使用した摺り合わせ加工であるため、加工皿をレンズの屈折率別、度数別に作製する必要がある。加工皿はアルミニウムや強化プラスチック、発砲ウレタン等を所望の形状に専用の装置で切削あるいは研削して作られる。加工皿は０．２５［D］毎に、度数範囲によっては更に細かいステップで揃える必要がある。その種類は第６図に示す製作範囲の場合、レンズの種類分すなわち２２２５個以上にもなる。現在眼鏡用プラスチックレンズとして使われるレンズ素材の屈折率は１．５０、１．５６、１．６０、１．６７の４種類が一般的であり、加工皿の形状は同じ度数でもレンズの屈折率によって異なるため、その必要数は８９００個以上にもなる。

【００１９】コスト的には、ランニングコストとしてこれら加工皿の管理工数、更には保管スペース、またイニシャルコストとして加工皿の製作コストが必要となる。その他コスト以外の点では加工皿の製作納期、また加工の原理上、及び生産性確保のためにプラスチック、ガラスを問わず、荒削り加工は所望の形状に近い形状に削り出すのみであり、加工面の形状精度は加工皿の形状を転写する砂掛け加工及び研磨加工工程で決まる。よって、形状精度を保証するには、その基である加工皿の製作時の加工誤差を厳密に管理する必要がある等、多くの問題点を有する。

【００２０】さらに、特願平７－３０６１８９には、従来、レンズの凸面側に創成されていた累進面と、処方に応じて凹面側に創成されていた球面あるいはトーリック

面とを組み合わせた曲面を、レンズの凹面側の一面に創成し、光学特性を飛躍的に向上させるという眼鏡レンズが提案されている。このような曲面をレンズ凹面側に有するレンズを以降内面累進多焦点レンズと呼ぶことにする。この内面累進多焦点レンズは、前記特開平５－１９２１２に示される注型成形によるレンズ製造方法によっても製造することができる。

【００２１】ここでレンズ凸面側に球面を有するタイプの内面累進多焦点レンズを、図６に示す製作範囲で製造する場合について考える。まず、凹面側に球面を有する上型の種類を１０ベースカーブ区分の１０種類とする。次に上型と組み合わせる下型だが、球面処方レンズ用に凸面側に累進面を有する下型を０．２５［Ｄ］ステップで２６２６種類、更に、乱視処方レンズ用には乱視軸毎に、累進面と処方に応じたトーリック面を組み合わせた曲面を凸面側に有する下型をＳ度数、Ｃ度数ともに０．２５［Ｄ］ステップで計９９４０３２０種類も保有する必要がある。仮に一種類あたりの下型の保有数を１０枚としても、型コストのみで数千億円にものぼる。また、これだけの種類の型の在庫管理は管理そのものが非現実的であり成り立たないこと、更には前にも述べたように、この注型成形によるレンズ製造方法ではプリズム量やレンズの厚みを指定する特殊処方レンズは製造できないものがある等の問題点を有する。

【００２２】また、従来、眼球側の面の創成などに用いられているカーブジェネレータは、その構造上、また加工皿と摺り合わせて加工する原理上、球面、トーリック面のいずれかしか加工ができず、前記に示した累進面と球面あるいはトーリック面とを組み合わせた曲面を創成することは完全に不可能である。

【００２３】そこで本発明においては、上記のように、従来の製造方法では現実的には供給が不可能な内面累進多焦点レンズを本格的に供給可能な眼鏡レンズの製造方法および製造装置を提供することを目的としている。さらに、累進多焦点レンズに限らず、従来の加工皿を用いた研磨加工による製造方法に代わり、短期間に低コストで多種多用な眼鏡レンズを製造可能な製造方法および製造装置を提供することも目的としており、加工皿そのものを省略でき、加工皿の製作コスト及び管理工数、保管スペースなどを省略できる製造方法および製造装置を提供することを目的としている。また、従来数ヶ月を要した加工皿の製作期間も不要とし、大幅なコストダウン、納期短縮を可能とすることも本発明の目的としている。

【００２４】

【課題を解決するための手段】このため、本発明においては、眼鏡レンズの面創成を数値制御加工用データ（以下、「ＮＣ加工用データ」ということもある。）に基づいて行うようにしている。すなわち、本発明の眼鏡レンズの製造方法は、眼鏡レンズの物体側の面または眼球側の面の少なくともいずれか一方の面の削り出し加工を数値制御加工用データに基づいて行うＮＣ形状創成工程を有することを特徴としている。また、本発明の眼鏡レンズの製造装置においては、眼鏡レンズの物体側の面または眼球側の面の少なくともいずれか一方の面の削り出し加工を行うための数値制御加工用データを記憶することができる記憶部と、眼鏡レンズをセットすることができる手段と、この眼鏡レンズの加工対象となる面の削り出し加工を数値制御加工用データに基づいて行うことができるＮＣ形状創成手段とを有することを特徴としている。

【００２５】本発明の眼鏡レンズの製造方法および製造装置は、従来の眼鏡レンズの製造には採用されていないＮＣ加工を眼鏡レンズの面自体の形状創成加工に採用することを特徴としており、本発明の製造方法あるいは製造装置を用いることにより、どのような曲面を備えた眼鏡レンズも共通した製造装置、あるいは数少ない種類の製造装置を用いてＮＣ加工用データを変えるだけで製造することができる。従って、本発明においては、眼鏡レンズの装用者（ユーザー、顧客）毎に異なる、累進面とトーリック面が合成された内面累進多焦点レンズの眼球側の面もＮＣ加工用データを変えることで加工することが可能であり、本発明の製造方法および製造装置を用いることにより、内面累進多焦点レンズを本格的に供給することができる。また、本発明においてはＮＣ加工用データを変えるだけで多種多用な眼鏡レンズを製造できるので、予め多種多用な加工皿を製造し、それらを管理する必要もなくなる。従って、様々なタイプの眼鏡レンズを低価格で供給することができ、その納期も大幅に短縮することが可能となる。

【００２６】ＮＣ加工を用いて眼鏡レンズの面形状の創成から仕上げまで単一の加工方法あるいは加工装置で行うことも可能である。しかしながら、高い面精度を要求される眼鏡レンズにおいては、面形状の創成からレンズ面の仕上げまで途中の段階で加工方法あるいは加工装置を変更することにより大幅に加工時間を短縮することができる。例えば、ＮＣ加工によって面形状を創成した後に、倣い研磨を行いレンズ面を仕上げることによって大幅に製造時間を短縮できる。また、ＮＣ加工工程によって面形状を創成したに後に、研磨する面形状を規定した数値制御加工用データに基づいて研磨加工を行うＮＣ研磨工程を行うことによっても製造時間を短縮することができる。さらに、製造時間を短縮するという点では、ＮＣ形状創成工程においてセミフィニッシュレンズの削り出し加工を行うことが有効である。

【００２７】このように、本発明の眼鏡レンズの製造方法および製造装置では、ＮＣ加工用データを変えることでどのような面を備えた眼鏡レンズでも製造できるのでＮＣ形状創成工程の前に、眼鏡レンズの装用者の条件を加味して加工対象の眼鏡レンズ毎にＮＣ加工用データを作成することにより、個々のユーザーに適したカスタマ

イズされた眼鏡レンズを本格的に製造し、提供することができる。

【0028】また、NC加工用データに基づき削り出し加工を行うのに適したセミフィニッシュレンズを選択すると共に、加工対象となるセミフィニッシュレンズの加工対象の面の形状を計測し、NC加工用データを補正することにより、セミフィニッシュレンズの誤差なども加味した実際に削り出し加工を行うのに適したNC加工用データを作成し、それに基づいて加工を行うことができる。

【0029】また、本発明の眼鏡レンズの製造方法のNC形状創成工程は、削り出し加工が行われた面の最大表面粗さRmaxが0．010mm以下になるように削り出し加工を行うようにすることができる。この条件を用いれば、その後の砂掛け工程を実施することなく研磨工程を実施したとしても、研磨工程に要する時間を不必要に長時間にすることもなく、所望の光学面をもった眼鏡レンズを短時間で製造することが可能となる。なお、NC形状創成工程で削り出し加工の行われた面の最大表面粗さRmaxを光学面程度に小さくすれば、そのままで又はその後にハードコーティングを行うことによって、研磨工程そのものを不要とすることもできる。

【0030】また、本発明の眼鏡レンズの製造方法は、NC形状創成工程で被加工面の最大表面粗さRmaxが0．001mm以上かつ0．010mm以下になるように削り出し加工を行った後に、その面の研磨を倣い研磨により行うようにすることができる。この条件を用いれば、NC形状創成工程に要する時間を不必要に長時間にすることもなく、所望の光学面をもった形状精度、外観精度のよい眼鏡レンズを短時間で製造することが可能となる。ここで、最大表面粗さRmaxを0．001mm以上としたのは、0．001mm未満にすると、NC形状創成工程に要する時間が不必要に長くなってしまうからである。この場合、0．002mm以上とするのが好ましく、0．003mm以上とするのがより好ましい。

【0031】また、本発明の眼鏡レンズの製造方法のNC形状創成工程は、削り出し加工を行う際に被加工面に生成される変曲点近傍の段差量が、面粗度成分を除いて、0．005mm以下になるように削り出し加工を行うようにすることができる。この条件を用いれば、段差を除去するための砂掛け工程を実施することなく研磨工程を実施したとしても、研磨工程に要する時間が長くなることもなく、所望の光学面をもった眼鏡レンズを短時間で製造することが可能となる。ここで、段差量を0．005mm以下としたのは、0．005mmを超えた範囲としたうえで砂掛け工程を省略した場合、研磨工程に要する時間が長くなる傾向にあり好ましくないからであり、たとえ長時間研磨工程を実施したとしてもこの段差を完全に除去するのは困難であり、さらに仮にこの段差を完全に除去することができたとしても長時間の研磨工程を経ることによって形状創成工程で創成された光学面の形状精度を悪化させてしまったり研磨ダレを発生させてしまったりしてしまうからである。また、砂掛け工程が省略できるため、砂掛け工程で必要であった研磨皿を不要にすることができるという効果がある。

【0032】また、本発明の眼鏡レンズの製造方法は、削り出し加工を行う際に生成される変曲点近傍の段差量が、面粗度成分を除いて、0．0005mm以上かつ0．005mm以下になるように削り出し加工を行った後に、その面の研磨を倣い研磨により行うようにすることができる。この条件を用いれば、段差の発生の極めて小さい高価なNC形状創成装置を用いる必要がなく、製造コストを低減することができる。また、段差の発生を抑えるために加工スピードを遅くする必要もないので、NC形状創成工程に要する時間を不必要に長時間にすることもなく、所望の光学面をもった形状精度、外観精度のよい眼鏡レンズを短時間で製造することが可能となる。

【0033】

【発明の実施の形態】プラスチック製眼鏡レンズを例に、本発明に係る眼鏡レンズの製造方法及び装置を説明する。図1にブロック図を用いて示すように顧客から得た処方データ１００が、レンズメーカーの製造部門のホストコンピュータ１０１へ送信される。この処方データには、一般的に、累進多焦点レンズの場合はＳ度数、Ｃ度数、乱視軸、加入度、プリズム、レンズ厚み、レンズ径、カラー等が含まれる。また、単焦点レンズの場合はＳ度数、Ｃ度数、乱視軸、プリズム、レンズ厚み、レンズ径、カラー等の処方データが含まれ、これらの処方データ１００が眼鏡小売店に備えられた端末機からオンラインにより直接レンズメーカーの製造部門のホストコンピュータ１０１へ送信される。あるいは、小売店から中継拠点が電話、ファクシミリ等の伝送手段で処方データ１００を受け、この中継拠点からオンライン送信されるようになっている。そして、これらのホストコンピュータ１０１に送信された処方データ１００に基づき、計算工程１０２において、計算用コンピュータで上記処方データが製造ライン用の製造データに加工され、この製造データに基づいて、つまりは顧客の処方に基づいた曲面の組み合わせの計算が行われ、顧客の処方毎にレンズ形状が設計される。この計算工程１０２はNC加工用の加工用データ生成工程としての機能を備えており、以下で説明する形状創成工程１０６で使用する図２に示す数値制御切削機、あるいは図３に示す数値制御旋削機でレンズ設計形状を創成するためのNC加工用データ（第１のNC加工用データ）、及び図５に示す数値制御研磨機で形状創成工程で創成された曲面を研磨するためのNC加工用データ（第２のNC加工用データ）、さらには、図４に示す倣い研磨機の研磨条件も同時に計算が行われ、これらが計算用コンピュータに装備された記憶装置にス

トックされる。

【0034】続いてセミフィニッシュレンズを選択するレンズ選択工程１０３では顧客の処方を満足するレンズを加工する元となるセミフィニッシュレンズを選び出す。このセミフィニッシュレンズを選択する工程１０３では、該当するセミフィニッシュレンズを手動でピッキングするか、もしくは自動倉庫等を使って自動的にピッキングを行う。

【0035】セミフィニッシュレンズは従来技術の中でも述べているように、型を使って注型成形により製造されるが、同じ型で成形しても重合条件、アニール条件等でセミフィニッシュレンズ毎にその形状が異なり、場合によっては型の形状を十分に転写できないことがある。このような場合は、往々にして所望のセミフィニッシュレンズの形状精度が得られていない。このため、セミフィニッシュレンズの計測要否判断工程１０４を設け、計測および計算工程１０５で、選択されたセミフィニッシュレンズの形状を予め計測し、この計測結果から所望のレンズ度数を得るための基準カーブを計算用コンピュータで算出し、創成する曲面の計算にフィードバックする。このような補正を行う工程１０５を設けておくことにより、セミフィニッシュレンズの形状誤差がキャンセルされ、結果として所望のレンズ度数を得るために創成すべき曲面を得ることが可能となる。その際、形状測定する面は選択されたセミフィニッシュレンズの凹凸面の内、形状創成したい面とは逆側の面のみで良い。形状測定の方法としては、測定面が球面形状をしたセミフィニッシュレンズであれば、ランクテーラーホブソン製の商品名：フォームタリサーフのような断面形状測定器で曲率半径を簡単に測定することができる。また、測定したい面が累進面等のように自由曲面を有する場合は干渉計を使った形状測定器や三次元測定器等を用いて形状測定を行うことが可能である。

【0036】なお、セミフィニッシュレンズの形状精度が安定している場合は、要否判断工程１０４で判断し、計測工程（補正工程）１０５を不要とすることができる。この安定した形状精度とは、測定面が球面の場合を例にとれば、同一製造ロット中のセミフィニッシュレンズの球面の曲率半径すなわちカーブの標準偏差がレンズ度数公差の４分の１以下で、かつカーブの平均値と公称カーブとの差が度数公差の５分の１以下を目安としている。また、測定面が自由曲面の場合もこの考えを応用して目安を設定することができる。

【0037】次に、形状創成工程（ＮＣ加工工程）１０６で個々のユーザーの処方データに基づいて生成されたＮＣ加工用データに従って面形状が生成され、さらに、研磨要否を判断する工程１０７で研磨が必要となった場合は研磨工程１０８が行われ、最後に検査工程１０９で検査が行われ、これらの工程を経て眼鏡レンズが製造される。

【0038】以下では、形状創成工程１０６以下についてさらに詳しく説明する。先ず、形状創成工程１０６では、セミフィニッシュレンズ選択工程１０３で選択されたセミフィニッシュレンズを図２に示す眼鏡レンズ製造装置１５０の数値制御切削機２００のチャック２０２にセットし、計算用コンピュータ１０１の記憶装置にストックされた形状創成用のＮＣ加工用データ（第１のＮＣ加工用データ）を数値制御切削機２００に伝送し形状創成が行われる。通常、ＮＣ加工用データは膨大なデータ量となるため数値制御切削機内の記憶装置に一旦記憶するか、ＮＣ加工用データをダイレクトに数値制御切削機に送り込んで機械を動かし形状創成を行う。なお、形状創成の手段としては前記数値制御切削機の他、数値制御研削機や数値制御旋削機を用いても同等の形状創成が可能である。

【0039】なお、これら形状創成手段で使用する刃具は切削加工であれば、ダイヤモンドカッターや超硬カッター等、研削加工であればメタルボンドや電着のダイヤモンドホイール等、また旋削加工であればダイヤモンドや超硬等のバイトが挙げられる。これらの形状創成手段を用いた形状創成工程では荒加工と仕上げ加工がワンチャックで行われ、仕上げ加工では加工後のワークの表面粗さを最大表面粗さR_{max}（以下R_{max}とする）で０．０１〜１０［μｍ］以下に仕上げる。また、必要に応じて次工程に研磨工程１０８を設け所望の光学面を得ることができることは図１に示した通りである。プラスチックレンズの素材にもよるが、この表面粗さをR_{max}で０．０５［μｍ］以下とすればプラスチック製眼鏡レンズの場合、研磨工程１０８を省略しても形状創成工程１０６に続くハードコート工程（不図示）で表面処理を施すことで所望の光学面を得ることができる。なお、表面粗さが同一でも、ハードコート工程で表面処理を施すことで所望の光学面を得ることができるか否かは、プラスチックレンズ素材によって大きく左右される。

【0040】一方、ハードコート工程で表面処理を施すだけでは所望の光学面を得ることができない場合には、形状創成の後に研磨工程１０８を設け、形状創成後のレンズ表面を平滑な光学面に研磨して仕上げる。具体的には図４に示す倣い研磨機４００、あるいは図５に示す数値制御研磨機５００による第２のＮＣ加工工程を行い、形状創成工程１０６で創成された曲面形状を崩すことなく所望の光学面に研磨する。これら研磨手段は、弾性を有するポリシャヘッドを装備しているが、レイヨン、ナイロン等を原料とした長さ０．１〜５［ｍｍ］程度の毛足を有する不織布をポリシャヘッドの表面に配し、更には、Al_2O_3を砥材の主成分とし、これに酸化物、水等を混合した研磨液を研磨対象ワークと前記不織布との間に注水することで研磨能率を向上させることも可能である。

【0041】（実施例１）以下では、特願平７－３０６

189に提案されている、累進面とトーリック面とを組み合わせた曲面をレンズの凹面側に持つ内面累進多焦点レンズを製造する場合を例に、各工程および各装置をさらに詳しく説明する。本例の処方データ100には、レンズ径80［mm］、球面度数（S度数）＋2．00［D］、乱視度数（C度数）－1．75［D］、乱視軸55度、加入度2．25［D］、プリズム1．20ダウンというユーザー（顧客）の個人情報が含まれている。まず、前記の処方を満足するためにレンズの凹面側に創成する、ベースカーブ4．00［D］、加入度2．25［D］の累進面と、乱視度数－1．75［D］でレンズ凹面側から見て累進面の主子午線に対し左回りに35度の方向にベースカーブ軸を持つトーリック面とが凹面一面に合成された曲面を計算用コンピュータにより計算した。この際、レンズの仕上がり中心厚みも同時に計算し、その結果は3．35［mm］であった。これらの計算に続いて前記で計算された曲面を図2に示す数値制御切削機200で加工するためのNC加工用データが計算工程102で計算用コンピュータで作成され、計算用コンピュータに装備されているハードディスクに記録される。

【0042】次に前記処方を満足する内面累進多焦点レンズを得るためのセミフィニッシュレンズが選択工程103で選択するわけだが、本例では凸面側に球面を有し、その曲率半径が110．333［mm］で公称6．00［D］のベースカーブを有するセミフィニッシュレンズを選択した。セミフィニッシュレンズのレンズ素材の屈折率は1．662である。また、選択したセミフィニッシュレンズが含まれる同一製造ロット中でのベースカーブのばらつきは標準偏差で0．005［D］と小さく形状精度は極めて安定していた。また、ベースカーブの平均値は5．998［D］と、公称ベースカーブとの差が極めて小さい。このため、形状要否判断工程104で形状測定工程105は不要と判断し、計算用コンピュータで計算されたレンズ設計形状の修正は指示されない。なお、前記セミフィニッシュレンズの製造ロットの構成は30枚／ロットである。

【0043】続いて、形状創成工程106では、セミフィニッシュレンズを数値制御切削機200のワークチャック202により把持し、数値制御切削機200のDNC運転モードを使い、前記のNC加工用データをホストコンピュータ101から数値制御切削機200に直接伝送しながらレンズ設計形状を切削加工により形状創成する。本例の数値制御切削機200の構成は、時2に示されるように、ほぼ水平方向に直線位置決めを行うX軸位置決め手段205、前記X軸位置決め手段205とほぼ直交する水平方向に直線位置決めを行うY軸位置決め手段208、ほぼ鉛直方向に直線位置決めを行うZ軸位置決め手段212、前記Z軸位置決め手段212上に取り付けられた刃具回転手段213、角度割り出し可能なワーク軸回転手段216とから構成される。Z軸位置決め手段212はワーク201と円形カッター215の芯高を合わせることを主目的に設けられている。X軸位置決め手段205、Y軸位置決め手段208、ワーク軸回転手段216の3軸を使ってワーク加工点に立てた法線方向に円形カッター215の中心座標を位置決めする。この加工点に対応した円形カッター215の中心座標の位置決めを連続して行うことでレンズ設計形状に基づいた形状創成を行う。

【0044】本例に用いた数値制御切削機200の最小位置決め精度は、直線位置決め手段が0．1［μm］、ワーク軸回転手段は0．001［°］である。また、ワーク半径方向の送りピッチは0．5［mm／回転］、ワーク周方向の角度分割ピッチは1周を360に分割し、仕上げ切り込み量3．0［mm］、刃具は直径70．2［mm］で2枚刃の超硬カッターを刃具回転手段により15000［r．p．m］で回転させ使用した。この条件のもと切削加工された曲面の形状は処方を満足するには十分な形状精度が得られていた。

【0045】数値制御切削機200を形状創成工程106に用いた場合で、得られた眼鏡レンズの表面粗さはRmax で4．5［μm］と切削加工のみではレンズに必要な光学面が得られないときは、続いて研磨加工105が実施される。本例では、眼鏡レンズ製造装置150のうち、図4に示す倣い研磨機400を用いて前記形状創成工程で創成された曲面の研磨を行う。倣い研磨機400の装置構成としては、ワーク回転軸403、ポリシャ回転軸407、図示しないが矢印408に示される方向に揺動を行う揺動軸、研磨液等を注水する注水手段409とからなり、また、図示しない荷重付加手段によりワーク401とポリシャヘッド410の間に研磨に必要な圧力を発生させることが可能である。ポリシャヘッド410はゴム等柔軟性を有するシート404とポリシャヘッド筐体405とで構成されており、このシート404とポリシャヘッド筐体405との間の密閉された空間に、406に示される圧縮空気等の気体、もしくは水等の液体を圧入させ、その圧力でシート404を膨らませることで、任意のワーク形状に倣うことが可能となる。膨んだシート404がワーク401の形状に倣う状態で、ワーク回転軸403、ポリシャ回転軸407を回転させるとともに前記揺動軸で揺動動作を加え、注水手段409から研磨液を注水することで、前記形状創成工程で創成されたワーク形状を崩すことなく所望の光学面に研磨することが可能となる。また、研磨対象ワークの素材に応じてシート404の表面に図示しない研磨布を貼り、更に研磨性能を向上することも可能である。

【0046】この構成のもと本例では、図示しないが、レイヨンを原料とする長さ0．8［mm］の毛足を有する不織布を接着剤によりシート404の表面に貼り付けるとともに、シート404とポリシャヘッド筐体405

との間の密閉された空間に約３．２［ｋｇｆ／ｃｍ^{2}］の圧縮空気４０６を送り込み、形状創成工程で創成された曲面にシート４０４がほぼ倣うようにシート４０４を膨らませた。更に図示しない荷重付加手段を用い、ワーク４０１とポリシャヘッド４１０との間に約３２．５［ｋｇｆ／ｃｍ^{2}］の圧力を発生させた。この状態でポリシャヘッド軸４０７を約１００［ｒ．ｐ．ｍ］、ワーク軸４０３を約５［ｒ．ｐ．ｍ］で回転させ、なおかつ図示しない揺動手段で１分あたり６往復の揺動動作を加えた。なお、これら一連の動作中、ワーク４０１とポリシャヘッド４１０との間には注水手段４０９から研磨液４１１（フジミインコーポレイテッド製　商品名：ポリプラ１０３Ａ）を注水した。その結果、約１０［分］で必要な光学面を得ることができた。また、前記形状創成時の形状をほとんど崩すことなく研磨加工されていたため、寸度検査時の測定値は、レンズ径８０．０９［ｍｍ］、Ｓ度数＋２．０２［Ｄ］、Ｃ度数－１．７７［Ｄ］、乱視軸５５［°］、加入度２．２５［Ｄ］、プリズム１．１７ダウン、仕上がり中心厚み３．３１［ｍｍ］と、いずれの測定値も規格値を満たしており、処方を十分に満足する内面累進多焦点レンズを得ることができた。

【００４７】なお、図２に示す数値制御切削機は、使用する刃具を円形カッター２１５からメタルボンド等の研削用砥石に変更することで数値制御研削機としても使用可能で、数値制御切削機と同等の形状精度、表面粗さを得ることができる。

【００４８】また、数値制御切削機２００を図３に示す数値制御旋削機３００に置き換えてもほぼ同様の結果を得ることができる。数値制御旋削機３００は、ほぼ水平方向に直線位置決めを行うＸ軸位置決め手段３０５、前記Ｘ軸位置決め手段３０５とほぼ直交する水平方向に直線位置決めを行うＹ軸位置決め手段３０８、角度割り出し可能なワーク軸回転手段３０６、刃物台３１１とから構成される。数値制御旋削機は前記数値制御切削機と同様に、Ｘ軸位置決め手段３０５、Ｙ軸位置決め手段３０８、ワーク軸回転手段３０６の３軸を使ってワーク３０１の加工点に立てた法線方向にバイト３０７の先端Ｒの中心座標を位置決めする。この加工点に対応したバイト３０７の先端Ｒの中心座標の位置決めを連続して行うことでレンズ設計形状に基づいた形状創成を行う。この際、ワーク３０１はワークの形状や荒、仕上げ加工別に１００～２０００［ｒ．ｐ．ｍ］の間の回転数でワーク軸回転手段３０６により回転される。

【００４９】また、本例では研磨工程１０８で倣い研磨機４００を使用したが、図５に示す数値制御研磨機５００を使用し、研磨用のＮＣ加工用データ（第２のＮＣ加工用データ）を用いて研磨を行ってもほぼ同等の結果が得られていることは言うまでもない。数値制御研磨機５００は図５に示されるように、ほぼ水平方向に直線位置決めを行うＸ軸位置決め手段５０５、前記Ｘ軸位置決め手段５０５とほぼ直交する水平方向に直線位置決めを行うＹ軸位置決め手段５０７、角度割り出し機能を有する回転テーブル５０３、角度割り出し機能を有するＲ軸位置決め手段５０４の４軸、もしくは前記Ｘ軸位置決め手段５０５、前記回転テーブル５０３、前記Ｒ軸位置決め手段５０４の３軸とレンズの設計形状から予め計算しておいたＮＣ加工用データに基づき、ポリシャヘッド５１０とワーク５０１との相対位置決めを行い、かつワーク５０１の加工点における法線方向にポリシャヘッド５１０の中心軸もしくはポリシャヘッド５１０の表面の任意の部位を一致させ、その方向から荷重付加手段５１３でポリシャヘッド５１０を押し当て研磨加工する。これにより形状創成工程１０６で創成された曲面形状を崩すことなく所望の光学面に研磨することが可能である。

【００５０】（実施例２）次に、レンズの凸面側に累進面を有する累進多焦点レンズを本発明の製造方法により製造する場合の実施例を図面を用いて説明する。

【００５１】本例の処方データ１００には、レンズ径８０［ｍｍ］、球面度数（Ｓ度数）－３．２５［Ｄ］、乱視度数（Ｃ度数）－０．７５［Ｄ］、乱視軸９０度、加入度１．００［Ｄ］、ダウンプリズム０．７５というデータが含まれている。この処方を満足するために、セミフィニッシュレンズ選択工程１０３で選択されるセミフィニッシュレンズの凹面側に創成するベースカーブ５．７５［Ｄ］、クロスカーブ６．５０［Ｄ］のトーリック面を計算工程１０２で計算用コンピュータを使って計算した。この際、レンズの仕上がり中心厚みも同時に計算したところ１．５５［ｍｍ］であった。続いて計算されたトーリック面を図３に示す数値制御旋削機３００で加工するためのＮＣ加工用データを計算用コンピュータで作成し、計算用コンピュータ１０１に装備されているハードディスクに記録した。

【００５２】次にセミフィニッシュレンズ選択工程１０３で、前記処方を満足する累進多焦点レンズを得るためのセミフィニッシュレンズを選択するわけだが、本例では凸面側に基準曲率半径が２６４．８［ｍｍ］の公称２．５０［Ｄ］ベースカーブ、加入度１．００［Ｄ］の累進面を有する屈折率１．６６２のセミフィニッシュレンズを選択した。選択したセミフィニッシュレンズが含まれる同一製造ロットの中でのベースカーブのばらつきは標準偏差で０．０７２［Ｄ］と大きく、またベースカーブの平均値は２．５５１［Ｄ］と、形状精度が不安定であったため、計測要否判断工程１０４で計測が必要と判断し、計測工程１０５で三次元測定器により形状測定を行った。測定の結果、本例に用いるセミフィニッシュレンズのベースカーブは２．５４２［Ｄ］であった。よって、公称ベースカーブである２．５０［Ｄ］との差である０．０４２［Ｄ］分を修正したトーリック面を創成するために計算用コンピュータで再計算を行い、ＮＣ加

工用のデータを求めた。この際、レンズの仕上がり中心厚みもＮＣ加工用データと同時に再計算したが、仕上がり中心厚みに関しては再計算前と同一の数値であった。なお、前記セミフィニッシュレンズの製造ロットの構成は２０枚／ロットである。

【００５３】続いて前記セミフィニッシュレンズを、図３に示す数値制御旋削機３００のワークチャック３０２により把持し、数値制御旋削機のＤＮＣ運転モードを使い、前記のホストコンピュータ１０１に記憶されたＮＣ加工用データを数値制御旋削機３００に直接伝送しながら旋削加工により形状創成した。なお、数値制御旋削機３００の構成は、実施例１で述べた通りであるが、本例に用いた数値制御旋削機の最小位置決め精度は、直線位置決め手段が０．１［μｍ］、ワーク軸回転手段は０．０１［°］である。また、バイト３０７の先端Ｒは４．０［mm］、ワーク回転数は７５０［ｒ．ｐ．ｍ］、ワーク半径方向の送りピッチは０．０１［mm／回転］、ワーク周方向の角度分割ピッチは１周を３６０に分割し、仕上げ切り込み量は２．０［mm］であった。

【００５４】この条件のもと旋削加工された前記トーリック面の形状は処方を満足するには十分な形状精度が得られていた。更に、表面粗さはRmax で０．０１４［μｍ］と旋削加工のみで必要な光学面が得られたため、研磨要否判断工程１０７で研磨不要と判断され、研磨加工１０８は省略された。しかし、レンズメータでの寸度検査を行えるレベルの光学面には至っていなかったため、ハードコート加工を施した後に寸度検査を行った。その結果検査時の測定値は、レンズ径７９．９６［mm］、Ｓ度数－３．２６［Ｄ］、Ｃ度数－０．７７［Ｄ］、乱視軸９０［°］、加入度０．９８［Ｄ］、ダウンプリズム０．７５、仕上がり中心厚み１．５３［mm］と、いずれの測定値も規格値を満たしており、処方を十分に満足する累進多焦点レンズを得ることができた。

【００５５】なお、本実施例では形状創成の手段として数値制御旋削機３００を使用したが、実施例１と同様に数値制御切削機２００、あるいは数値制御研削機を使って形状創成を行ってもほぼ同等の結果が得られることは言うまでもない。但し、形状創成加工後の表面粗さの大きさによっては、実施例１のように倣い研磨機４００、あるいは数値制御研磨機５００での研磨加工が必要になる場合がある。

【００５６】希ではあるが、本例のようにセミフィニッシュレンズのベースカーブのばらつきが大きい、あるいは公称ベースカーブからのずれが大きいセミフィニッシュレンズが多量に含まれる製造ロットを使用する場合は、図１のブロック図の計算工程１０２とセミフィニッシュレンズ選択工程１０３の順番を入れ替えてレンズ製造を行った方が、再計算の手間が無くなり効率が向上する場合がある。

【００５７】（実施例３）続いて本発明の眼鏡レンズの製造方法により、セミフィニッシュレンズの凸面側に累進面を形状創成し、所望の累進多焦点レンズを製造する場合の実施例を図面を用いて説明する。

【００５８】本例の処方データ１００には、レンズ径７０［mm］、球面度数（Ｓ度数）－１０．５０［Ｄ］、加入度１．５０［Ｄ］、プリズム２．００アップのデータが含まれている。このため、処方を満足するために計算工程１０２において、セミフィニッシュレンズの凸面側に創成するベースカーブ１．００［Ｄ］、加入度１．５０［Ｄ］の累進面を計算用コンピュータにより計算した。この際、レンズの仕上がり厚みも同時に計算したところ１．０５［mm］であった。

【００５９】なお、本例では形状創成手段として第２図に示す数値制御切削機２００の円形カッター２１５を図示しないメタルボンドダイヤモンドホイールに変更し、数値制御研削機として使用した。

【００６０】続いて計算工程１０２で、前記で計算された累進面を、前記数値制御研削機で加工するためのＮＣ加工用データを計算用コンピュータで作成し、計算用コンピュータに装備されているハードディスクに記録した。

【００６１】次にセミフィニッシュレンズ選択工程１０３で前記処方を満足する累進多焦点レンズを得るためのセミフィニッシュレンズを選択するわけだが、本例では凹面側に球面を有する、その曲率半径が５７．５６５［mm］で公称１１．５０［Ｄ］のベースカーブを有するセミフィニッシュレンズを選択した。セミフィニッシュレンズのレンズ素材の屈折率は１．６６２である。また、選択したセミフィニッシュレンズが含まれる同一製造ロット中でのベースカーブのばらつきは標準偏差で０．００２［Ｄ］と小さく、形状精度は極めて安定していた。また、ベースカーブの平均値は１１．４９２［Ｄ］と、公称ベースカーブ値との差が極めて小さいため、実施例１と同様に前述の形状測定は不要であった。よって、前記で計算されたレンズ設計形状の修正は不要であった。なお、前記セミフィニッシュレンズの製造ロットの構成は３０枚／ロットである。

【００６２】続いて、形状創成工程１０６において、前記セミフィニッシュレンズを数値制御研削機の図示しないワークチャックにより把持し、数値制御研削機のＤＮＣ運転モードを使い、前記のＮＣ加工用データを数値制御研削機に直接伝送しながら、レンズ設計形状を研削加工により前記セミフィニッシュレンズの凸面側に形状創成した。数値制御研削機の構成は刃具の違いを除けば数値制御切削機と同じである。本例に用いた数値制御研削機の最小位置決め精度は、直線位置決め手段が０．１［μｍ］、ワーク軸回転手段は０．００１［°］である。また、ワーク半径方向の送りピッチは０．７５［mm／回転］、ワーク周方向の角度分割ピッチは１周を３６０に分割し、仕上げ切り込み量は０．２［mm］、刃

具は直径６８．２［mm］で５００メッシュのメタルボンドダイヤモンドホイールを刃具回転手段により１０００００［r．p．m］で回転させ使用した。この条件のもと研削加工された曲面の形状は、処方を満足するには十分な形状精度が得られていた。ただ、表面粗さはRmaxで６．２［μm］と研削加工のみではレンズに必要な光学面が得られなかった。

【００６３】このため、続いて研磨加工１０８を施した。本例では、図４に示す倣い研磨機を用いて形状創成された曲面の研磨を行った。倣い研磨機の装置構成は実施例１で説明した通りである。本例では、図示しないが、レイヨンを原料とする長さ０．８［mm］の毛足を有する不織布を接着剤によりシート４０４の表面に貼り付けるとともに、シート４０４とポリシャヘッド筐体４０５との間の密閉された空間に約２．４［kgf／cm２］の圧縮空気４０６を送り込み、形状創成された曲面にシート４０４がほぼ倣うようにシート４０４を膨らませた。さらに図示しない荷重付加手段を用い、ワーク４０１とポリシャヘッド４１０との間に約２６．９［kgf／cm^2）］の圧力を発生させた。この状態でポリシャヘッド軸４０７を約１２０［r．p．m］、ワーク軸４０３を約５［r．p．m］で回転させ、なおかつ図示しない揺動手段で１分あたり３往復の揺動動作を加えた。なお、これら一連の動作中、ワーク４０１とポリシャヘッド４１０との間には注水手段４０９から研磨液４１１（フジミインコーポレイテッド製　商品名：ポリプラ１０３A）を注水した。その結果、約１３［分］で必要な光学面を得ることができた。また、前記形状創成時の形状をほとんど崩すことなく研磨加工されていたため、寸度検査時の測定値はレンズ径７０．０６［mm］、S度数−１０．４６［D］、加入度１．５０［D］、プリズム１．９２アップ、仕上がり中心厚み１．１１［mm］と、いずれの測定値も規格値を満たしており、処方を十分に満足する累進多焦点レンズを得ることができた。

【００６４】以上に説明したように本例の眼鏡レンズの製造方法および製造装置によれば、顧客の処方に基づいて曲面の組み合わせを計算し、加工データを算出し、所望の曲面を創成する切削手段、もしくは研削手段、旋削手段、更にはこれらに加えセミフィニッシュレンズの形状を計測し所望の度数を得るための基準データを算出する手段、及び研磨手段により、処方に応じたあらゆる組み合わせの曲面の創成が可能である。この結果、従来技術では必須とされていた加工皿や多量の成型用の型が不要となるばかりでなく、様々なタイプの眼鏡レンズを容易に製造して低コストで供給することが可能となり、従来の累進多焦点レンズに限らず、従来技術の注型成形方法では莫大なコストと時間を要し、また、研磨加工による製造方法では現実的には製造不可能な、特願平７−３０６１８９に記載された内面累進多焦点眼鏡レンズをも短い納期と低コストで提供することができる等、多大な効果を有するものである。

【００６５】

【発明の効果】このように、本発明においては、眼鏡レンズの物体側の面または眼球側の面を、従来の注型成型、カーブジェネレータおよび加工皿を用いた研磨装置あるいはこれらを組み合わせた製造方法と異なり、NC加工用データに基づくNC加工によって製造するようにしている。このため、どのような曲面を備えた眼鏡レンズも共通した製造装置、あるいは数少ない種類の製造装置を用いてNC加工用データを変えるだけで製造することができる。従って、本発明においては、従来の製造方法では現実的には供給が不可能な内面累進多焦点レンズを本格的に供給することが可能となり、眼鏡レンズの装用者毎に異なる面を備えた眼鏡レンズを適当な納期と価格で提供することができる。また、本発明の製造方法および製造装置を用いることにより、NC加工用データを変えるだけで多種多用な眼鏡レンズを製造できるので、予め多種多用な加工皿を製造し、それらを管理する必要もなくなる。従って、内面累進多焦点レンズに限らず、様々なタイプの眼鏡レンズを低価格で供給することができ、その納期も大幅に短縮することが可能となる。

【図面の簡単な説明】

【図１】本発明における眼鏡レンズの製造工程を示すブロック図。

【図２】本発明の眼鏡レンズ製造装置の数値制御切削機を示す正面図。

【図３】本発明の眼鏡レンズ製造装置の数値制御旋削機を示す上面図。

【図４】本発明の眼鏡レンズ製造装置の倣い研磨機を示す正面図。

【図５】本発明の眼鏡レンズ製造装置の数値制御研磨機を示す正面図。

【図６】眼鏡レンズの一般的な製作範囲を示す製作範囲表。

【符号の説明】

１０１　ホストコンピュータ
１０２　計算工程
１０３　セミフィニッシュレンズ選択工程
１０４　セミフィニッシュレンズの計測要否判断工程
１０５　セミフィニッシュレンズの計測及び計算工程
１０６　形状創成工程
１０７　研磨要否判断工程
１０８　研磨工程
１０９　検査工程
２０１　ワーク
２０２　ワークチャック
２０３　ワーク回転軸駆動用モータ及びエンコーダ
２０４　ワーク回転軸
２０５　X軸位置決め手段

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206　X軸駆動用モータ及びエンコーダ
207　ベッド
208　Y軸位置決め手段
209　Y軸駆動用モータ及びエンコーダ
210　Z軸コラム
211　Z軸駆動用モータ及びエンコーダ
212　Z軸位置決め手段
213　刃具回転手段
214　刃具回転軸
215　円形カッター
216　ワーク軸回転手段
301　ワーク
302　ワークチャック
303　ワーク回転軸駆動用モータ及びエンコーダ
304　X軸駆動用モータ及びエンコーダ
305　X軸位置決め手段
306　ワーク軸回転手段
307　バイト
308　Y軸位置決め手段
309　Y軸駆動用モータ及びエンコーダ
310　ベッド
311　刃物台
401　ワーク
402　ワークチャック

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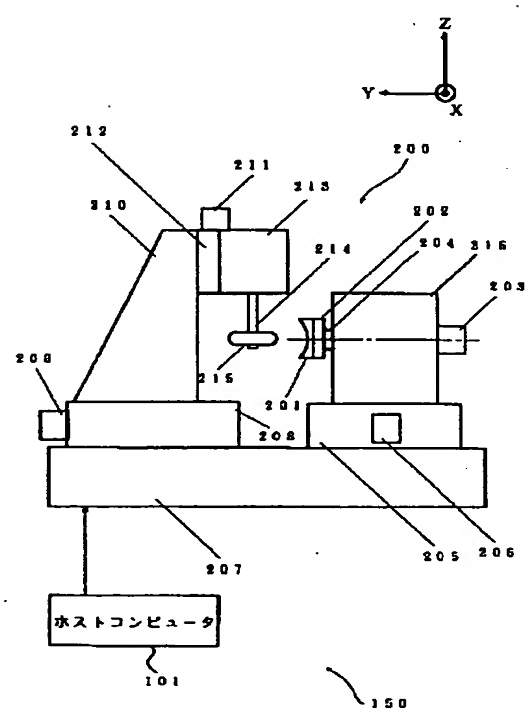
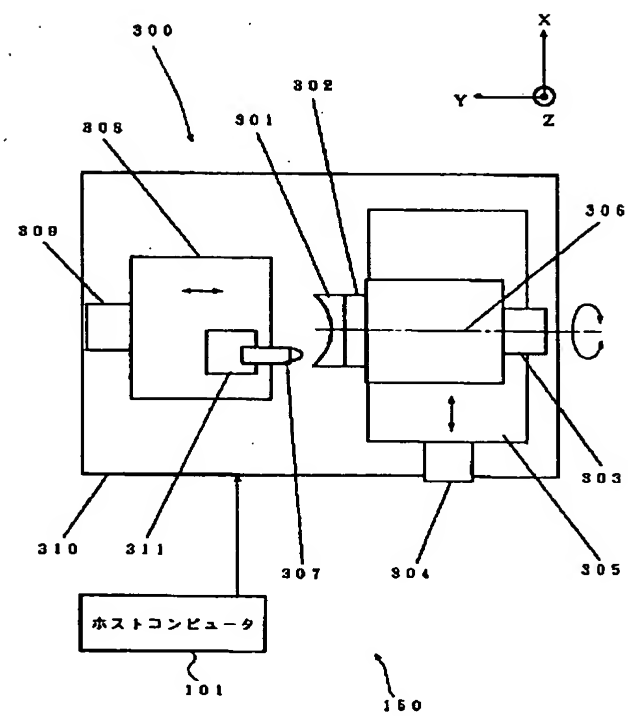
403　ワーク回転軸
404　柔軟性を有するシート
405　ポリシャヘッド筐体
406　圧縮空気等の気体、もしくは水等の液体
407　ポリシャヘッド回転中心軸
408　揺動方向
409　注水手段
410　ポリシャヘッド
411　研磨液
501　ワーク
502　ワークチャック
503　モータ及びエンコーダ内蔵の回転テーブル
504　R軸位置決め手段
505　X軸位置決め手段
506　X軸駆動用モータ及びエンコーダ
507　Y軸位置決め手段
508　ベッド
509　Y軸駆動用モータ及びエンコーダ
510　ポリシャヘッド
511　ポリシャヘッド回転手段
512　Z軸位置決め手段
513　荷重付加手段
514　Z軸駆動用モータ及びエンコーダ
515　荷重伝達軸

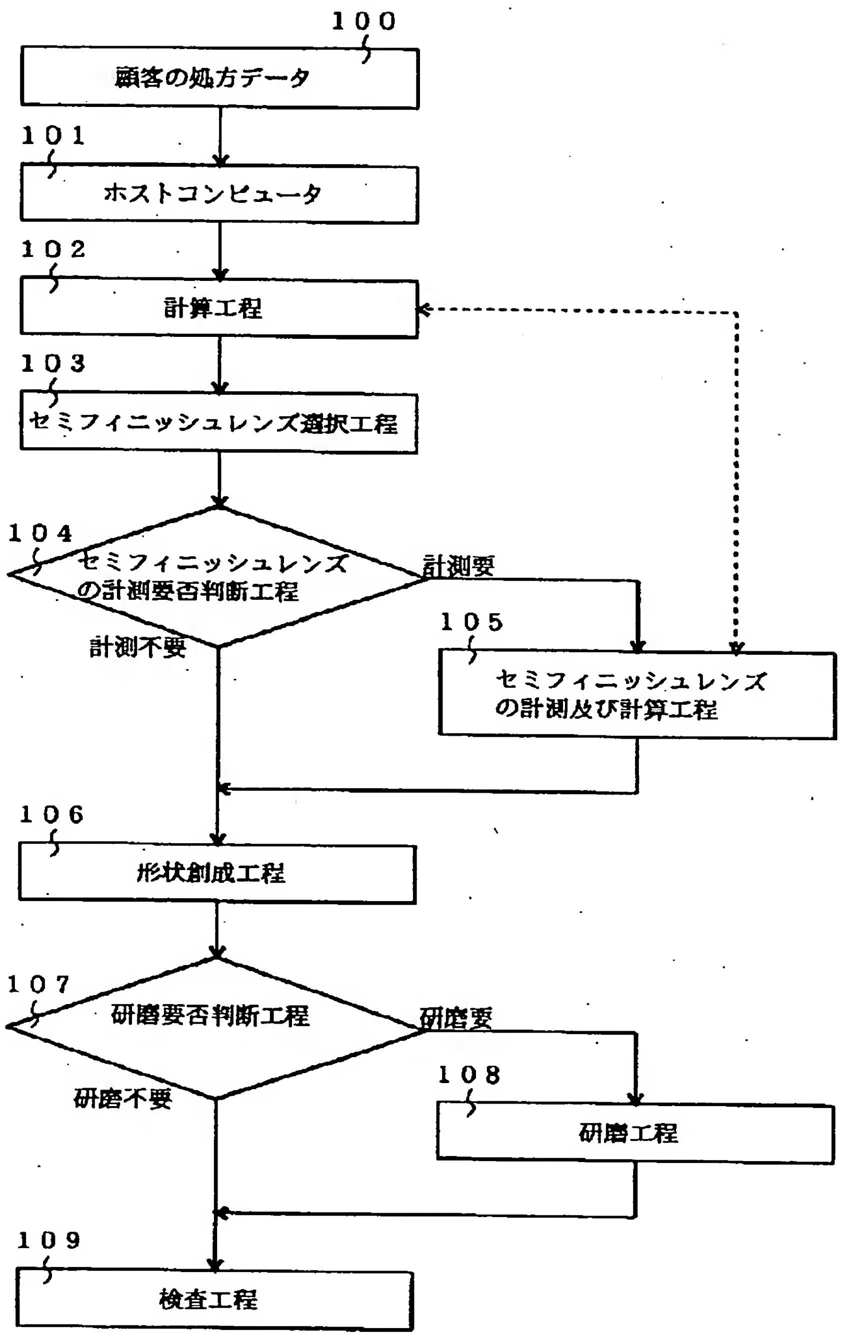
【図2】



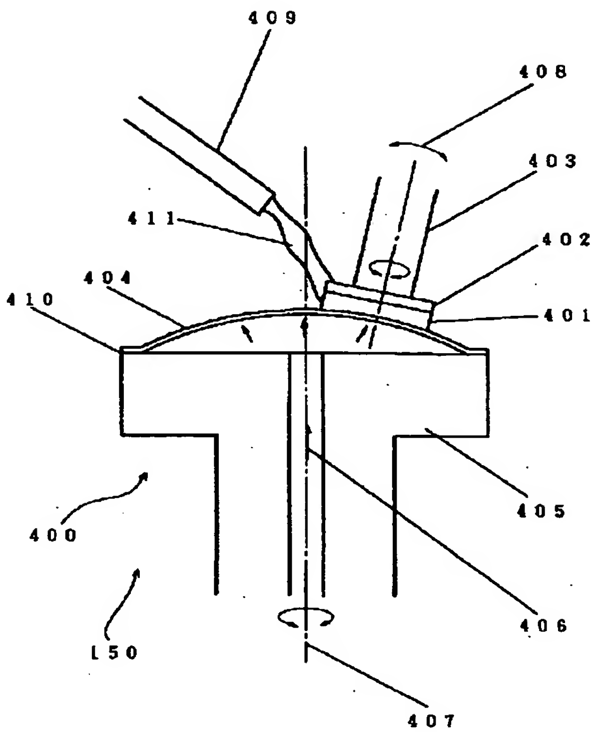
【図3】



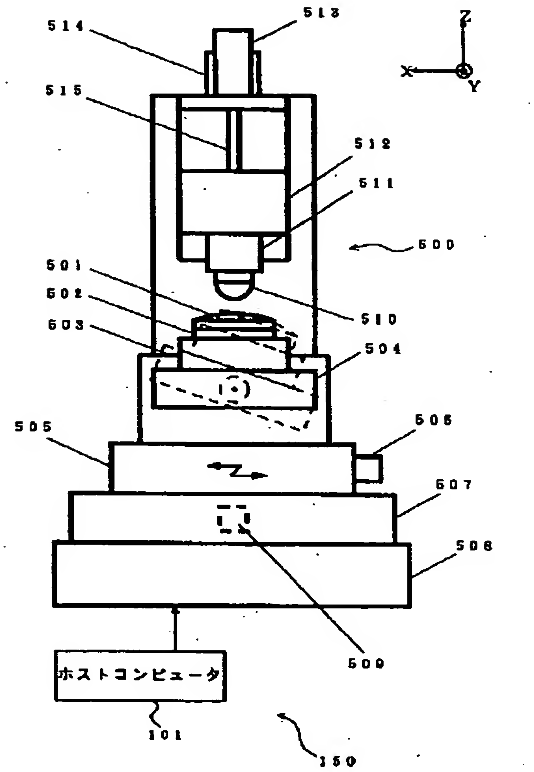
【図1】


100
顧客の処方データ
101
ホストコンピュータ
102
計算工程
103
セミフィニッシュレンズ選択工程
104
セミフィニッシュレンズの計測要否判断工程
計測要
計測不要
105
セミフィニッシュレンズの計測及び計算工程
106
形状創成工程
107
研磨要否判断工程
研磨要
研磨不要
108
研磨工程
109
検査工程

【図4】



【図5】



【図6】

S度数 \ C度数	—	-0.25	・・・・・・・	-6.00
+10.00				
+ 9.75				
⋮				
0.00				
⋮				
- 9.00				
⋮				
-14.50				
-14.75				
-15.00				

フロントページの続き

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